SCIENCE

VOL. 101 FRIDAY, JUNE 15, 1945 No. 2633

The Terminology of Seaweed Colloids: DR. C. K. TSENG 597

Obituary:
Milo Herrick Spaulding: PROFESSOR CLARENCE ARCHER TRYON, JR. *Recent Deaths* 602

Scientific Events:
The International Commission on Zoological Nomenclature; Anniversary of the Academy of Sciences of the U.S.S.R.; New Fluid Mechanics Laboratory at Syracuse University; Chapters of the Society of the Sigma Xi 602

Scientific Notes and News 605

Discussion:
Anthony Askham, the Author of the Voynich Manuscript: DR. LEONELL C. STRONG. *The Genetic Aspects of the Enzyme-Virus Theory of Cancer:* DR. VAN R. POTTER. *The Effect of Oxalates in the Diet:* DR. EDWARD F. KOHMAN. *"Angry" Mosquitoes:* DR. FRANK A. BEACH. *Pressure Due to Mounting Scientific Knowledge:* PROFESSOR H. M. DADOURIAN. *The Shortage of Scientific Personnel:* DR. PHILIP N. POWERS 608

Special Articles:
Crystalline Reineckates of Streptothricin and Streptomycin: DR. J. FRIED and DR. O. WINTERSTEINER. *Chronic Intermittent Anoxia and Impairment of Peripheral Vision:* PROFESSOR WARD C. HALSTEAD. *Inhibition of Growth of Mycobacterium Tuberculosis by a Mold Product:* DR. ISADORE E. GERBER and MILTON GROSS. *Sulfonamides and Egg-Shell Formation in the Domestic Fowl:* DR. RICHARD BERNARD and P. GENEST. *Oral Penicillin with Basic Aluminum Aminoacetate:* DR. JOHN C. KRANTZ, JR., DR. WILLIAM E. EVANS, JR. and DR. JAMES G. MCALPINE. *Corneal Vascularization in Rats on a Tryptophane Deficient Diet:* DR. ANTHONY A. ALBANESE. *The Solution of Soil Minerals in Dilute Acids:* DR. P. G. NUTTING 613

Scientific Apparatus and Laboratory Methods:
A Simplified Method for the Assay of Antibiotics: DR. IGOR N. ASHESHOV and FRIEDA STRELITZ. *Separatory Funnels as Experimental Chambers in Studies of Insect Physiology:* DR. CARROLL M. WILLIAMS 621

Scientific Books:
Immuno-Catalysis: DR. HENRY W. SCHERP. *Mosquitoes of New Jersey:* DR. HARRY B. WEISS 622

Science News 10

SCIENCE: A Weekly Journal, since 1900 the official organ of the American Association for the Advancement of Science. Published by the American Association for the Advancement of Science every Friday at Lancaster, Pennsylvania.

Editors: JOSEPHINE OWEN CATTELL and JAQUES CATTELL.

Policy Committee: MALCOLM H. SOULE, ROGER ADAMS and WALTER R. MILES.

Advertising Manager: THEO. J. CHRISTENSEN.

Communications relative to articles offered for publication should be addressed to Editors of Science, 34 Gramercy Park, New York 3, N. Y.

Communications relative to advertising should be addressed to THEO. CHRISTENSEN, Advertising Manager, Smithsonian Institution Building, Washington 25, D. C.

Communications relative to membership in the Association and to all matters of business of the Association should be addressed to the Permanent Secretary, A.A.A.S., Smithsonian Institution Building, Washington 25, D. C.

Annual subscription, $6.00 Single copies, 15 cents

THE TERMINOLOGY OF SEAWEED COLLOIDS[1]

By Dr. C. K. TSENG

SCRIPPS INSTITUTION OF OCEANOGRAPHY

SINCE the outbreak of the war, there has been a considerable interest among some of the United Nations in investigating and developing their seaweed resources. The principal stimulus, in most instances, has been an agar shortage. In 1940, America had a single agar factory, which made 24,000 pounds of agar. There are now four factories[2] actively engaged in this industry with a combined production capacity of about 200,000 pounds per annum. The principal agarophytes are *Gelidium cartilagineum* from California and Baja California, Mexico, and *Gracilaria confervoides* from Beaufort, N. C.[3]

The interest shown in agar does not stop there; it extends to related seaweed colloids capable of serving as substitutes for agar. One of these is carrageenin, generally known in commerce as Irish moss extract. Its principal source is carrageen, better known as Irish moss (*Chondrus crispus*), which is now obtained in large quantities from Massachusetts and Maine in the United States and from the Maritime Provinces in Canada. The name carrageen is also applied to *Gigartina stellata* (*G. mamillosa*), commonly harvested together with the *Chondrus* and used similarly. Previously the production of Irish moss extract was rather small, since most consumers preferred to buy the seaweed and make their own extract. In recent years, there has been a great demand by various industries for a highly purified, standardized product

[1] Contributions from the Scripps Institution of Oceanography, New Series No. 259.

[2] There are three more factories, still in the pilot plant stage, but expected to produce agar soon.

[3] C. K. Tseng, *Food Industries*, 17: 140, 1945.

and hence the production of the extract is greatly increased. At present there are in the United States at least three companies producing the extract and many others processing carrageen. It has been estimated that the United States made about half a million pounds of the extract in 1944.

The other seaweed colloid which has received considerable attention lately is algin, an alkali-extracted polysaccharide from various kinds of kelps and fucoids. In the United States the kelps utilized are *Laminaria digitata* (horsetail kelp) and *L. saccharina* (broadleaf kelp) from Maine and Nova Scotia, and *Macrocystis pyrifera* (giant kelp) from California. Although relatively young, the algin industry has been growing steadily and fast, especially in America and recently in Great Britain. This is shown by the fact that in 1941 the United States produced about one and one-half million dollars worth of algin.[4] War has greatly stimulated the growth of this industry, and undoubtedly much more algin is now being produced than in the pre-war period. There are four concerns in the United States making algin and its derivatives.

While seaweeds have served rather extensively as food in the Orient, they have never been as popularly utilized for culinary purposes by the Occidentals. In the past, soda, potash and iodine had been extracted, and organic solvents such as acetone derived from seaweeds on a large scale in America and Europe. In countries enjoying relatively high standards of living, these materials can no longer be produced profitably from marine plants, since they can be obtained more cheaply elsewhere. The important seaweed products in recent years have been the polysaccharides agar, algin and carrageenin. Because of their unique colloidal properties, these substances are valuable for special purposes and, in spite of their relatively high cost, have been extensively used in food, pharmaceutical, cosmetic and other industries. Agar, for instance, is still the undisputed material for preparing solid bacteriological culture media, and is extensively employed in bakery products, health food and dental impression materials. Algin is most valuable as an ice-cream stabilizer, and is regarded by dairy experts to be as good as, if not better than, gelatin, which was the standard stabilizer until recently. Carrageenin is now the standard suspending agent for cocoa particles in chocolate milk preparations. To the unique properties of these seaweed colloids the modern seaweed industry in the United States owes its existence and its present prosperity.

The increasing interest in seaweed polysaccharides will certainly lead to more research activities in the studies of these products and their sources from biological, chemical and technological points of view. The progress of such researches, however, will be greatly hindered by the loose and inconsistent, sometimes inaccurate, use of terms applying to these colloidal substances and their sources. It is the firm belief of the writer, therefore, that such confusion should be clarified, and the application of the different terms involved be standardized as far as our present knowledge of the sources and chemistry of these products permits. Whenever necessary, new terms should be introduced.

Phycocolloids. In the early days, when agar was the only commercial seaweed colloid, it was variously called "vegetable isinglass" or "vegetable gelatin." These terms have not been used in recent years, since it is well known that agar and the other commercial seaweed colloids are all polysaccharides and are not nitrogenous compounds as they were first thought to be. At present, they are commonly called "seaweed gums" and "seaweed mucilages" by various authors.

Gums occur chiefly as exudations on the barks of trees or on fruits, and mucilages are commonly extracted from seeds. Seaweed colloids, however, are chiefly cell wall constituents, comparable to the pectins of the land plants. They should therefore not be grouped with the gums and mucilages, in spite of certain resemblances, since they differ from the land plant products not only in origin, but also in chemical nature.

Phylogenetically, the primitive marine plants known as the brown and the red algae, from which we derive our agar, algin and carrageenin, are not directly related to the modern highly evolved land plants. There are consequently numerous differences between the plants of the sea and those on the land in their chemical constitution. For instance, it has been well established in recent years that chlorophyll *b* is not present in the brown and the red algae, which have, instead, chlorophyll *c* and *d*, respectively.[5] The kinds of reserve food of these seaweeds are also different from those of the land plants. The seaweed polysaccharides are consequently expected to be different chemically from their counterparts in the land plants. This is quite true, so far as our limited knowledge of their chemistry is concerned. The gums and mucilages are polyuronides consisting of several types of much branched monosaccharide units. The seaweed colloids, on the other hand, consist of generally one or two types of simple monosaccharide units, and with the exception of alginic acid, are not polyuronide. Although alginic acid resembles the gums in being a polyuronide, it is quite unique in being composed exclusively of mannuronic units.

[4] V. B. Scheffer, *Fish. Mark. News*, 5(6): 1, 1943.

[5] H. H. Strain and W. M. Manning, *Jour. Biol. Chem.*, 144: 625, 1942; W. M. Manning and H. H. Strain, *ibid.*, 151: 1, 1943.

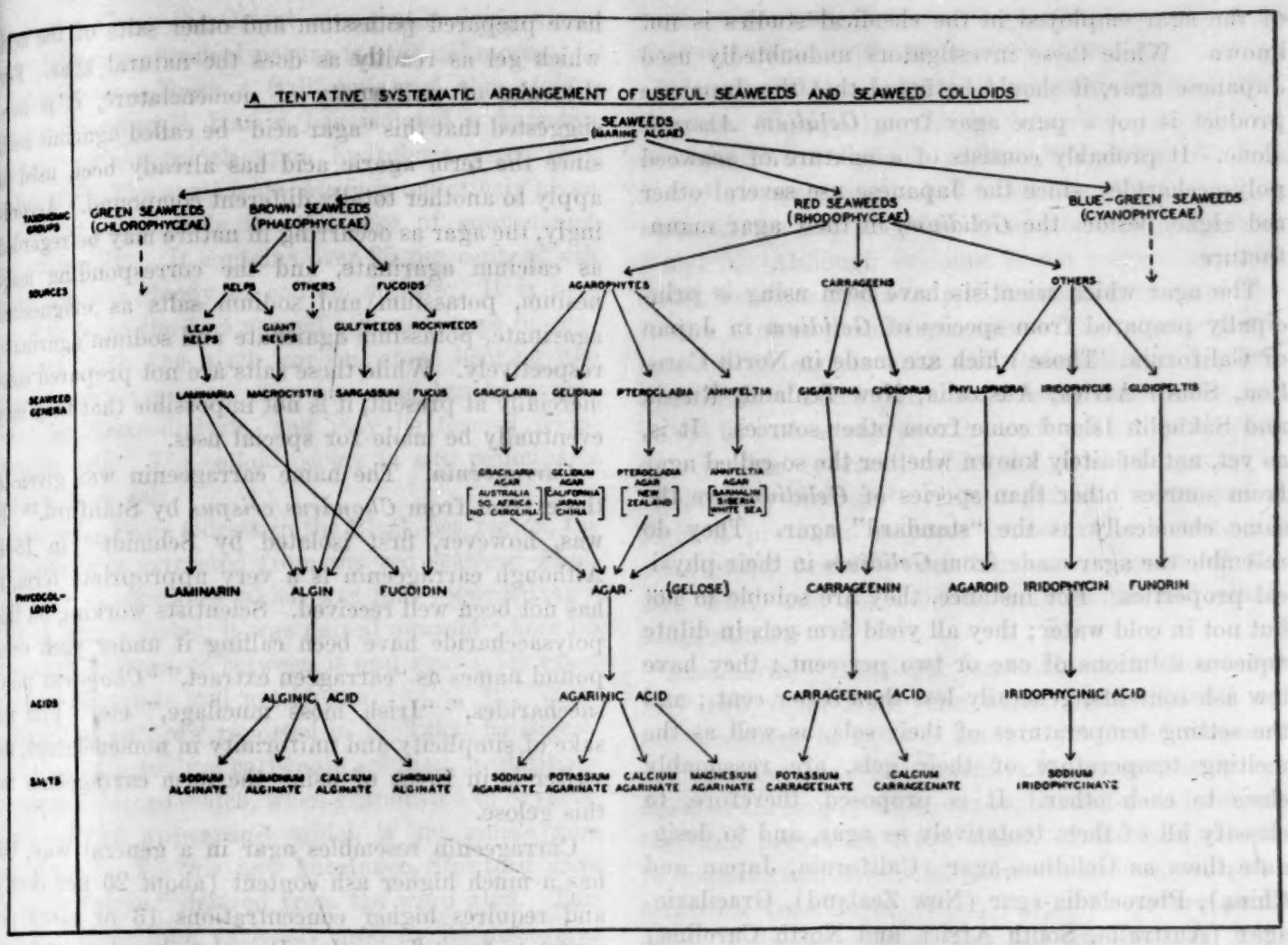


FIG. 1

That the seaweed polysaccharides should be divorced from the gums and mucilages has also been advocated by Norman,[6] who groups these marine products separately under "gel-forming substances." It should be noted, however, that, strictly speaking, not all the commercial seaweed colloids are gel-forming. Moreover, the use of such a complex term is rather inconvenient. The new term "phycocolloid"[7] has therefore been proposed to designate the polysaccharides which are derived from the brown and the red seaweeds and are able to form colloidal systems when dispersed in water.

Gelose. Payen[8] proposed the term "gelose" to designate the refined extract from "mousse de Chine" or "Chinese moss," under which name agar was known when first introduced into France from China in 1856. Later, various authors used the same term to refer to carrageenin. "Gelose" is a well-selected term, and is worthy of being kept to designate collectively the red algal extracts, such as agar and carrageenin, aqueous solutions of which are able to form a more or less firm jelly. It can not be used to include all the seaweed polysaccharides, however, since some of them, the alginates, for instance, are not strictly gel-forming substances.

Agar. The writer[9] has previously pointed out the existing confusion in the usage of the word "agar" or "agar-agar." To avoid using the same word in two or three different meanings, the writer has proposed the word *agarophyte* to refer to the agar-bearing seaweeds and to restrict the use of the word agar exclusively to the dried extract.

Chemically, agar is the sulfuric ester of a linear galactan. It consists of a long chain of *d*-galactopyranose residues, attached by 1:3-glycosidic linkages. This chain is terminated at the reducing end by one residue of *l*-galactopyranose. Attached to the rest of the chain through carbon atom 4, this *l*-galactose residue is esterified at carbon atom 6 with sulfuric acid.[10] There are probably as many as 53 galactose units to each SO_4H group, and at least 140 such units to each nonreducing end group.[11] Our present knowledge of the chemistry of agar is still incomplete. Moreover, with one exception,[11] the previous history

[6] A. G. Norman, "The Biochemistry of Cellulose, Polyuronides, Lignin," etc., 1937, Oxford.

[7] From Greek φῦκος (seaweed) and κόλλα (glue) + -oid. C. K. Tseng, "Phycocolloids: Useful Seaweed Polysaccharides" in Jerome Alexander, "Colloid Chemistry," vol. VI (in press), Reinhold Publishing Company.

[8] M. Payen, *Compt. rend.*, Paris, 49: 521, 1859.

[9] C. K. Tseng, *Sci. Monthly*, 58: 24, 1944.

[10] W. G. M. Jones and S. Peat, *Jour. Chem. Soc.*, 1942: 225.

[11] V. C. Barry and Thomas Dillon, *Chem. and Ind.*, 1944: 167.

of the agar employed in the chemical studies is not known. While these investigators undoubtedly used Japanese agar, it should be noted that the Japanese product is not a pure agar from *Gelidium Amansii* alone. It probably consists of a mixture of seaweed polysaccharides, since the Japanese use several other red algae, besides the *Gelidium,* in their agar manufacture.

The agar which scientists have been using is principally prepared from species of *Gelidium* in Japan or California. Those which are made in North Carolina, South Africa, Australia, New Zealand, Russia and Sakhalin Island come from other sources. It is, as yet, not definitely known whether the so-called agar from sources other than species of *Gelidium* are the same chemically as the "standard" agar. They do resemble the agar made from *Gelidium* in their physical properties. For instance, they are soluble in hot but not in cold water; they all yield firm gels in dilute aqueous solutions of one or two per cent.; they have low ash contents, generally less than 5 per cent.; and the setting temperatures of their sols, as well as the melting temperature of their gels, are reasonably close to each other. It is proposed, therefore, to classify all of them tentatively as agar, and to designate them as Gelidium-agar (California, Japan and China), Pterocladia-agar (New Zealand), Gracilaria-agar (Australia, South Africa and North Carolina) and Ahnfeltia-agar (Sakhalin Island and White Sea, Russia).[12]

Any attempt at a critical definition of agar is, of course, premature. Nevertheless, a tentative definition will help in the clarification of the conception of agar. The writer has previously proposed such a definition.[9] It is slightly modified and presented as follows: The dried amorphous, gelatin-like, non-nitrogenous extract from *Gelidium* and other agarophytes, being the sulfuric acid ester of a linear galactan, insoluble in cold but soluble in hot water, a one per cent. neutral solution of which sets at 35° to 50° C to a firm gel, melting at 80° to 100° C.

It has been observed by various investigators that when agar is hydrolyzed with an acid, a free "agar-acid" is formed which fails to gel until neutralized by the addition of a base. It is also quite generally accepted that in the natural condition agar probably occurs as the calcium salt, or a mixture of calcium and magnesium salts of this free "agar-acid." Fairbrother and Mastin[13] and Hoffman and Gortner[14] have prepared potassium and other salts of the acid which gel as readily as does the natural agar. For the sake of uniformity of nomenclature, it is here suggested that this "agar-acid" be called agarinic acid, since the term agaric acid has already been used to apply to another totally different compound. Accordingly, the agar as occurring in nature may be regarded as calcium agarinate, and the corresponding magnesium, potassium and sodium salts as magnesium agarinate, potassium agarinate and sodium agarinate, respectively. While these salts are not prepared commercially at present, it is not impossible that they may eventually be made for special uses.

Carrageenin. The name carrageenin was given to the extract from *Chondrus crispus* by Stanford.[15] It was, however, first isolated by Schmidt[16] in 1844. Although carrageenin is a very appropriate term, it has not been well received. Scientists working on this polysaccharide have been calling it under such compound names as "carrageen extract," "*Chondrus* polysaccharides," "Irish moss mucilage," etc. For the sake of simplicity and uniformity in nomenclature, the writer is in favor of using the term carrageenin for this gelose.

Carrageenin resembles agar in a general way, but has a much higher ash content (about 20 per cent.), and requires higher concentrations (3 or more per cent.) to form firm gels. Its gel melts at much lower temperatures (27° to 30° C for a 3 per cent. gel and 40° to 41° C for a 5 per cent. gel).[17] Chemically, carrageenin is similar to agar in being a carbohydrate ethereal sulfate and in containing galactose residues[18] joined by 1:3-linkages. The sulfuric ester group, however, is attached to carbon atom 4, not 6. The galactosidal linkages combining the residues seem to be of the α-type. Like agar, carrageenin is considered to be a cell wall constituent, and is presumed to occur *in situ* as a mixture of sodium, potassium and calcium salts.[19] While the acid is still imperfectly known, it may be conveniently called carrageenic acid. The carrageenin in the natural condition is accordingly a mixture of sodium, potassium and calcium carrageenates.

Funorin. This term has recently been used to designate the polysaccharide of *Gloiopeltis* (funori in Japanese),[20] which gives the gluey extract used for hun-

[12] This is better known as Sakhalin agar, since it was first extracted from *Ahnfeltia plicata* from Sakhalin Island (or Karafuto) by a Japanese about forty years ago. The seaweed was subsequently found in large quantity in the White Sea region.

[13] F. Fairbrother and H. Mastin, *Jour. Chem. Soc.*, 123: 1412, 1923.

[14] W. F. Hoffman and R. A. Gortner, *Jour. Biol. Chem.*, 65: 371, 1925.

[15] E. C. C. Stanford, *Jour. Soc. Arts*, 10: 185, 1862.

[16] Carl Schmidt, *Annal. Chem. und Pharm.*, 51: 29, 1844.

[17] Paul Haas and T. G. Hill, *Ann. Appl. Biol.*, 7: 352, 1921.

[18] E. G. Young and F. A. H. Rice have recently reported in *Jour. Biol. Chem.*, 156 (2): 781, 1945, the isolation in considerable quantity of 2-ketogluconic acid as a constituent of carrageenin, in addition to the galactose residues.

[19] J. Buchanan, E. E. Percival and E. G. V. Percival, *Jour. Chem. Soc.*, 1943: 51.

[20] C. K. Tseng, *Sci. Monthly*, 59: 37, 1944.

dreds of years in the Orient as a textile-sizing material. Its exact chemical nature is still unknown.

Iridophycin. From a California red alga, *Iridophycus flaccidum,*[21] Hassid has isolated a galactan ethereal sulfate, which upon hydrolysis gives only galactose.[22] The name *iridophycin* is tentatively given to this polysaccharide for the sake of convenience and uniformity. It contains over 25 per cent. of ash which consists chiefly of sodium sulfate. It is presumed to be of the 1:4 normal pyranose type of constitution, with the sixth carbon atom bearing the ethereal sulfate group. The free acid has been prepared by electrodialysis, and may be termed iridophycinic acid. The colloid occurs *in situ* principally as its sodium salt.

Agaroid. From Odessa in the Black Sea region, the Russians have extracted from the red seaweed *Phyllophora,*[23] a substance which was first regarded as a kind of agar. Later, it was named agaroid[24] because of certain differences between it and agar. Its exact chemical nature is still not known.

Algin. Stanford[25] reported in 1883 that by digesting kelps with sodium carbonate solution, a glutinous mass was obtained which, when evaporated to dryness, presented "an appearance which is not unlike gum tragacanth." To this new substance Stanford gave the name "algin," derived from the word alga. This term has since been variously used by its discoverer and others to apply to: (1) sodium salt of the substance; (2) natural state of this substance, which according to some, may be the calcium salt; (3) alginic acid; (4) soluble alginates, and (5) alginic acid and its salts in general. As it is used in commerce to-day, "algin" refers to the soluble alginates, especially sodium alginate and, to a lesser extent, ammonium alginate. To avoid confusion, the term algin is better restricted to sodium alginate, which is the primary product in all the processes of manufacture and from which other alginates are derived. Since "agar" and "carrageenin" have been accepted to designate respectively the water-extracted colloids from agarophytes and carrageens, it is logical to limit the use of "algin" to the soda-extracted substance, *i.e.,* sodium alginate, from kelps. The other alginous products may be designated as ammonium algin, calcium algin, chromium algin, etc. From the limited information we have at present, it seems that algin from different sources belongs to the same chemical entity.

Alginic acid is a polyuronic acid with the empirical formula $(C_6H_8O_6)_n$. It is composed entirely of *d*-mannuronic anhydride residues,[26] in which the hydroxyl groups are attached to carbon atoms 2 and 3, while bridge and ring are attached to carbon atoms 4 and 5. Although evidence is not yet sufficient to decide between pyranose and furanose structures, the former is more probable, in view of the large negative rotation of alginic acid and its resistance towards hydrolysis. Thus, the mannuronic acid units are linked in such a way that the carboxyl group on each unit is free to react, while the aldehyde group is shielded by linkage.[27] Like agar and carrageenin, algin is presumed to occur in nature as a cell wall constituent, probably existing as a mixture of the acid itself and its calcium, magnesium and alkali metal salts.

Laminarin. Although laminarin was discovered only two years later than algin, being isolated by Schmiedeberg in 1885, it has not yet found commercial applications. Laminarin is the reserve carbohydrate of the kelps, analogous to, but different in structure and properties from, starch of the land plants. It consists exclusively of glucose residues, with the empirical formula of $(C_6H_{10}O_5)_n$. There are probably 16 glucose units, which are combined by 1:3-glycosidic linkages. The linkages in laminarin are regarded to be of the β-type.[28]

Fucoidin. In 1913 Kylin[29] reported that he had extracted from *Laminaria* and *Fucus* a new polysaccharide which he called "fucoidin." A similar water-soluble carbohydrate was isolated from the giant kelp, *Macrocystis pyrifera,* by Hoagland and Lieb[30] in 1915. Fucoidin is presumably a carbohydrate ethereal sulfate, occurring in nature as a calcium salt. On hydrolysis, it gives rise to pentoses and methyl-pentoses, particularly fucose. Like laminarin, fucoidin has not yet found commercial uses.

Classification of phycocolloids. In view of our incomplete knowledge of their chemistry, it is still too early to propose a critical classification of seaweed colloids. It may be said, however, that there seem to be three groups of the phycocolloids. First of all, we

[21] Erroneously called *Iridaea* (*Iridea*) *laminarioides* by various authors; *cf.* G. M. Smith, "Marine Algae of the Monterey Peninsula," p. 288, 1944, Stanford.

[22] W. Z. Hassid, *Jour. Am. Chem. Soc.,* 55: 4163, 1933; *ibid.,* 57: 2046, 1935; *Plant Physiol.,* 11: 461, 1936.

[23] V. L. Elin, R. Grayerova and G. Fisher, *Bull. Nauch. Issledovatel Khim-Farm. Inst.,* 1931: 140; A. Korentzvit, *Khim-Farm. Prom.,* 1934(4): 36.

[24] V. Gryuner and N. Tauson, *Colloid Jour.* (*U.S.S.R.*), 2: 783, 1936; V. Gryuner and L. Veronyan, *ibid.,* 5: 851, 1939.

[25] E. C. C. Stanford, *Chem. News,* 47: 254, 1883.

[26] V. C. Barry and T. Dillon, in *Sci. Proc. Roy. Dublin Soc.,* 21: 285, 1936, expressed their conviction that the polymerizing unit in alginic acid is the complete uronic acid and not the anhydride, and hence the empirical formula for alginic acid should be $(C_6H_8O_6 \cdot H_2O)_n$.

[27] E. L. Hirst, J. K. N. Jones and W. O. Jones, *Jour. Chem. Soc.,* 1939: 1880.

[28] V. C. Barry, *Sci. Proc. Roy. Dublin Soc.,* 21: 615, 1938.

[29] Harold Kylin, *Z. Physiol. Chem.,* 83: 171, 1913.

[30] D. R. Hoagland and L. L. Lieb, *Jour. Biol. Chem.,* 23(1): 287, 1915.

have the water-soluble ethereal sulfates as represented by agar, carrageenin and fucoidin; they are similar to the mucilages in some of their properties. Secondly, there are the water-soluble reserve carbohydrates consisting exclusively of glucose units; they are represented by laminarin and occupy a position similar to that of starch in the land plants. In the third group we have the alkali-soluble polyuronides, represented by algin, which are analogous to pectin. The accompanying diagram summarizes the writer's view of the sources of these interesting seaweed colloids, or phycocolloids, and their interrelationship. It is to be noted that there are as yet no commercial colloids extracted from the other two seaweed groups, the green algae (Chlorophyceae) and the blue-green (Cyanophyceae).

OBITUARY

MILO HERRICK SPAULDING

Herrick Spaulding was born on June 10, 1879, at Rutland, Vermont. He died on Easter Sunday, April 1, 1945, after a long illness. At the time of his death he was professor of zoology at Montana State College, where he had taught for thirty-seven years. He was a member of Sigma Xi, Phi Kappa Phi and Phi Sigma as well as many of the technical societies in his two main fields of mammalian anatomy and embryology. He was graduated from Stanford University in 1903 and received the M.A. degree in 1906 from the same institution.

Herrick Spaulding was one of the real old-time zoologists—painstaking in detail, patient and a never-ending source of help and encouragement. Not only his colleagues but two generations of students will remember him, as a teacher, for longer than we remember most.

Clarence Archer Tryon, Jr.
Montana State College

RECENT DEATHS

Dr. William Worthington Herrick, president of the New York Academy of Medicine, died on June 1 at the age of sixty-six years.

Dr. Merton Benway Waite, principal plant pathologist at the station at Beltsville, Md., of the U. S. Department of Agriculture, with which he had been associated for more than fifty years, died on June 6 at the age of eighty years.

Curtis J. Hesse, curator of the museum of the Agricultural and Mechanical College of Texas, died on May 8. Mr. Hesse was a vertebrate paleontologist who had specialized in the vertebrate faunas of the later Tertiary beds of the Gulf Coast Plain.

Nature reports the death on May 7 of Dr. K. J. W. Craik, director of the unit of applied psychology of the Medical Research Council, at the age of thirty-one years, and of Thomas J. Nolan, since 1932 professor of chemistry at University College, Dublin, on March 12 at the age of fifty-six years.

SCIENTIFIC EVENTS

THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The International Commission on Zoological Nomenclature announces its intention of publishing at an early date a revised and up-to-date edition (1) of the International Code of Zoological Nomenclature and (2) of the Official List of Generic Names in Zoology. The following is a statement of the plans:

The International Code of Zoological Nomenclature

The last edition of the English text was published some years before the war and is now out of date for various reasons, including the adoption by the International Congress of Zoology of changes in some of the articles in the International Code. The International Commission has, therefore, arranged for the early publication of a revised and up-to-date edition consisting of the substantive French text (on left-hand pages) and the English translation (on right-hand pages). The volume, which will be fully indexed, will also contain a detailed analysis of all the "Opinions" so far rendered by the International Commission in regard to the interpretation of the provision of the code.

The Official List of Generic Names in Zoology

The "Official List" was established by the International Congress of Zoology at its meeting at Monaco in 1913 for the purpose of recording full particulars relating to the names of the 5,000 to 10,000 best-known and most important genera in the Animal Kingdom with their type species. So far, however, only about 700 names have been placed on the "Official List." This is largely due to the fact that the decisions taken by the International Commission have never hitherto been brought together in a single volume and with a full index.

The International Commission attaches great importance to the "Official List," which they hope will velop into a powerful instrument for stabilizing ological nomenclature. The International Commission believes that the forthcoming publication of the fficial List" in book form will be of great practical lue to workers in many fields. It is the hope of the mmission that its publication will stimulate specialists to make proposals for the addition to the "Official st" of other generic names of importance not only systematic zoology but also in the applied sciences d in the teaching of zoology at the universities.

The International Commission is anxious to issue ch of the above works at the lowest possible price, r they desire that both shall be within the financial eans of every zoologist. It will only be possible for e International Commission to achieve this object, before publication they are assured of a sufficient lume of immediate sales. Zoologists are accordingly vited at once to register themselves as prospective bscribers. As soon as the publication price has been xed, a notification will be sent to all such subscribers ho will be granted a discount of twenty per cent. the publication price, provided that payment at the duced rate is made to the commission before the date publication. All inquiries should be addressed to e International Commission on Zoological Nomenature at their Publications Office, 41 Queen's Gate, ondon, S.W.7.

FRANCIS HEMMING,
Secretary to the International Commission on Zoological Nomenclature

MAY 8, 1945

ANNIVERSARY OF THE ACADEMY OF SCIENCES OF THE U.S.S.R.

A NUMBER of scientific men, including members of e American Philosophical Society, the National cademy of Sciences, the American Academy of Arts nd Sciences and the Society of the Sigma Xi, left ew York this week by plane to attend at the invitaion of the Soviet Government the two hundred and wentieth anniversary of the Academy of Sciences f the Union of Soviet Socialist Republics, which ill be held from June 15 to 28 in Moscow and eningrad.

Dr. Harlow Shapley, director of the Harvard Colege Observatory, will represent the Society of Sigma i and the Independent Citizens' Committee of the rts, Sciences and Professions at the anniversary elebration. Dr. Detlev W. Bronk, professor of biophysics at the University of Pennsylvania, will repreent the National Academy of Sciences.

A scroll containing greetings to the scientific men f the Soviet Union signed by twelve Americans was resented to Dr. Shapley by Dr. Harold C. Urey, rofessor of chemistry at Columbia University.

Among those included in the party in addition to Dr. Shapley and Dr. Bronk are Dr. James W. Alexander, professor of mathematics at the Institute for Advanced Study, Princeton, N. J.; Dr. James E. Church, of Reno, meteorologist for the U. S. Weather Bureau; Dr. Edward U. Condon, associate director of the research laboratory of Westinghouse Electric Corporation, East Pittsburgh, Pa.; Dr. Henry Field, of the Library of Congress; Dr. Isaac M. Kolthoff, head of the department of chemistry of the University of Minnesota; Dr. Irving Langmuir, associate director of the research laboratory of the General Electric Company, Schenectady, N. Y.; Dr. James W. McBain, professor of chemistry at Stanford University; Dr. Duncan A. MacInnes, member of the Rockefeller Institute for Medical Research; Dr. Arpad L. Nadai, consulting engineer of the Westinghouse Laboratory; Arthur Upham Pope, archeologist and director of the Iranian Institute, New York; Edwin S. Smith, director of the National Council of American-Soviet Friendship, Inc.; Manuel S. Vallarta, president of the Mexican Academy of Sciences.

While in Russia Dr. Shapley expects to observe the total solar eclipse of July 9, which will originate in Idaho and terminate in Siberia. Members of the eclipse party will include Dr. Duncan MacInnes, Dr. Irving Langmuir, Dr. Henry Field, Dr. Edward U. Condon and Manuel S. Vallarta.

NEW FLUID MECHANICS LABORATORY AT SYRACUSE UNIVERSITY

A NEW Fluid Mechanics Laboratory, which will be devoted to experimental and test work in the field of fluid mechanics, and featuring pump testing and analyses of performance of pumps, is being installed in the College of Applied Science of Syracuse University.

This new addition to the facilities of the department of mechanical engineering has been made possible by a recent gift of $10,000 from the Oberdorfer Foundries, Inc., of Syracuse, N. Y., through its president, Kenneth A. Digney.

This laboratory will be in Machinery Hall in a space along the west wall on the same floor as the machine shop. This space, 21 feet by 44 feet, is enclosed by a partition wall of frame construction with a wall covering of heavy plywood to a height of eight feet with glass enclosure above this height reaching to the ceiling, which is about fifteen feet above floor level. The heavy plywood wall covering was chosen in preference to plaster or other materials so as to resist without serious damage the impact of accidental blows from tools or from machinery being moved and, also, to permit easy mounting of lightweight instruments on the walls. A partition wall divides the space into two rooms, allowing a smaller

room, ten feet by twenty-one feet, at the north end, which is to be used as a computation and record room. The floor of the main laboratory room is provided with a waterproof mulsomastic covering pitched downward toward a drain outlet located near the center of the room, and is flashed with sheet lead around the walls. A drain pipe to the sewer has been installed and the piping for the water supply has been completed. Further installation details await delivery of the principal machinery now on order.

The immediate purposes of this laboratory are to provide testing facilities for determining the characteristics of pumps of rotary and centrifugal types, and to permit testing under unusual service conditions to observe effects of erosion and corrosion. The information so gained can then be used in the development of improved designs.

It is planned that the laboratory will be further developed to include facilities for research, experimentation and demonstration in the mechanics of fluids (both liquids and gases) for the benefit of graduate and undergraduate students.

In the testing of pumps the power input will be provided by direct coupling to 220-volt, direct-current electrical, cradle-type dynamometers, three of which have been ordered. These dynamometers have motoring capacities of 40 horsepower, 5 horsepower and ½ horsepower, with speed variations from 1,200 r.p.m. to 5,000 r.p.m. The small unit will be included in a bench set-up for which a suitable laboratory bench equipped with drain has been provided. The largest unit will be mounted on a steel-slotted engine base about five feet wide by fourteen feet long, which will be provided with adjustable supports for mounting pumps of various designs or dimensions. This same base and driving unit will be equally well adapted to the testing of rotary, centrifugal or axial flow gas compressors. It is expected that the units to be tested will be changed frequently, hence a monorail running the length of the laboratory and extending to an outside door of the building will be installed. This will be equipped with a hoist capable of lifting the machines to be tested from grade level, about twelve feet below the floor level at this outside door. A precision, air-balance type, recording flow meter along with suitable accessory air-compressor equipment has been ordered. Also, there will be provided various types of flow-measuring devices, including venturi meters, orifice meters and nozzles. Much of the latter equipment, along with necessary instruments, is available in present laboratory equipment. Following the installation of the equipment now on order the piping arrangements will be completed, including tanks and drums to contain the fluids to be handled. Weighing tanks mounted on platform scales will be added. Part of the piping and storage tanks will be adapted to the handling of corrosive solutions of various sorts.

In addition to the equipment provided for testing machinery there will be developed and built various types of apparatus for demonstration and experimental work in the flow of fluids. Also, it is planned that various installations will be made from time to time for research purposes. In general, the idea prevails that this is not to be a fixed installation to be retained as originally made for a period of years; but is to be a very flexible laboratory installation capable of following closely the needs and trends of industry in the field of fluid mechanics.

FLUID LABORATORY

Objectives: Testing facilities for determining characteristics of pumps.
Development of pumps.
Facilities for student research, experiments and demonstrations in the mechanics of fluids.

Equipment: 3 dynamometers accommodating pumps from fractional HP sizes to 40 HP.
Precision, air-balance type recording flow meter.
Air compressor.
Gages, miscellaneous.
Tanks and drums suitable for adapting equipment to various fluids.
Record files, drafting facilities, technical reference literature.
Laboratory benches and cabinets.

Difficulties in getting materials, equipment and problems of constructing special test stands, etc., are delaying factors.

Laboratory space: Laboratory 34 × 21 and adjoining office 10 × 21. Totally enclosed. Located in Machinery Hall.

1/2 HP at 1,800/5,000 r.p.m.
5 HP at 1,250/4,000 r.p.m.
40 HP at 1,550/4,000 r.p.m.

JOHN A. KING
SYRACUSE UNIVERSITY

CHAPTERS OF THE SOCIETY OF THE SIGMA XI

THE Cornell Chapter of the Society of Sigma Xi held its annual initiation on May 23. President O. F. Curtis spoke on "Biological Science in the News." Following the banquet, Professor A. A. Allen, of Cornell University, gave an illustrated lecture on "The Bird's World." The Cornell Chapter has recently written to all former members in connection with its affiliation program. The portion of all affiliates' dues which remains with the local chapter will be used for the establishment of the Cornell Sigma Xi Fellowship, with a stipend of $500. It is anticipated that the first award will be made in 1946.

years after the founding of Sigma Xi at Cornell versity.

he Western Reserve University Chapter has ted the following officers for 1945–46: *President,* Helen A. Hunscher; *Vice-president,* Dr. Harry blatt; *Secretary,* Dr. Moffatt G. Boyce; *Treaer,* Dr. A. Sidney Harris.

t the Princeton University Chapter on June 5, the owing new officers were elected: *President,* E. W. gstrom, director of research, RCA Laboratories, nceton; *Vice-president,* Professor W. O. Puckett, artment of biology; *Secretary,* Professor M. H. hols, department of physics; *Treasurer,* Professor H. Wilhelm, Engineering School; *Committeeman,* W. M. Stanley, the Rockefeller Institute for dical Research.

he Purdue University Chapter initiated twenty- new members and associates at a meeting on May At the close of the initiation exercises, new officers e elected as follows: *President,* W. L. Ayers; *Vicesident,* L. Greene; *Secretary,* Elizabeth Mackay; *easurer,* J. Tiffin. An important feature of the iation dinner was the presentation of the first nual research award to be made by the chapter. was presented by Professor C. V. Ludy, a charter mber, to Donald J. Belcher in recognition of reeh on engineering characteristics of soils deterned from studies of aerial photographs. The award consisted of a certificate, fifty dollars in cash and a plaque to commemorate the establishment of the award on which Mr. Belcher's name is the first to be engraved. Mr. Belcher has been invited to discuss his work before the chapter on some future date.

At a meeting which celebrated the tenth anniversary of the Smith College Chapter Dr. Albert Blakeslee, president, reviewed the decade of scientific achievement at Smith and welcomed seven graduate students and nineteen seniors into associate membership in the society. Dr. Katharine Blodgett, of the General Electric Company, gave an address on "The Colors of Thin Films."

The Abbott Laboratories Science Club, Chicago, is the first research group in the pharmaceutical industry to qualify for and be granted affiliation with the Society of the Sigma Xi. One hundred and eighty-four chemists, engineers, pharmacists, bacteriologists, pharmacologists, physiologists, physicians, botanists and other scientifically trained personnel of the laboratories attended the installation, which was held at the Georgian Hotel at Evanston, Ill. Dr. George A. Baitsell, professor of biology at Yale University and executive secretary of the society, conducted the installation ceremonies and presented the charter. Dr. Michael Heidelberger, professor of biochemistry at the College of Physicians and Surgeons of Columbia University, gave the address of the evening. It was entitled "Blood Complement."

SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of science was conrred on the occasion of the one hundred and ninetyst commencement exercises of Columbia University Professor Edwin Joseph Cohn, of the Harvard edical School, and on Dr. Herbert Gasser, director the Rockefeller Institute for Medical Research.

DR. W. B. R. KING, Woodwardian professor of ology in the University of Cambridge, has been arded the Prestwich Prize of the Geological Society France in recognition of his "distinguished reearches and also for his services to France in *la ologie militaire* during the War of 1914–18 and 39–45 as geological adviser to the British Army."

THE medal of the Liverpool Geological Society has en awarded to Dr. Douglas A. Allan, director of the oyal Scottish Museum, Edinburgh, in recognition of s original geological work, mainly connected with e structure and petrology of the Highland Border Scotland and Angus, and in acknowledgment of s great services to the society.

THE Trudeau Medal of the National Tuberculosis ssociation was awarded at a meeting of the executive committee of the association on June 6 to Dr. Florence R. Sabin, emeritus member of the Rockefeller Institute for Medical Research, in recognition of her work on the pathology of tuberculosis and on the origin, nature and activities of the white blood cells. The medal is given annually for "meritorious contribution to the cause, treatment or prevention of tuberculosis."

THE Chauvenet Prize for 1941–43 has been awarded by the Mathematical Association of America to Professor R. H. Cameron, of the Massachusetts Institute of Technology.

ACCORDING to a wireless dispatch to *The New York Times,* Prince Louis de Broglie was admitted to the French Academy in the first public session that it has held since 1939. The address of welcome was made by Duc Maurice de Broglie, his brother, who was elected to the academy ten years ago. Both are physicists.

DR. GEORGE D. STODDARD, Commissioner of Education, and president of the University of the State of New York, who was for seventeen years a member

of the faculty of the State University of Iowa, has been elected president of the University of Illinois, where he will take up the work on July 1 of next year. He will succeed President Arthur Cutts Willard, who reaches the retiring age in August, 1946.

DR. JOHN LEWIS JONES, since 1920 head of the department of mathematics of the University of Akron, will retire from active work in September.

THE retirement in July is announced of Dr. J. H. McDonald, professor of mathematics at the University of California at Berkeley. He joined the faculty in 1902.

DR. JOHN HASTINGS, for twenty-one years professor of anthropological and economic geography at the College of the City of New York, has retired.

DR. RAYMOND M. FUOSS, research chemist of the General Electric Company, has been appointed Sterling professor of chemistry at Yale University, the appointment to take effect on July 1.

DR. FRANK M. CARPENTER has been promoted to a professorship of entomology and to the Alexander Agassiz professorship of zoology at Harvard University.

DR. H. B. TUKEY, professor of pomology at the New York State Agricultural College, has been appointed head of the department of horticulture of the Michigan State College.

H. K. WILSON, professor of agronomy at the University of Minnesota, will become head of the department of agronomy of the Pennsylvania State College. He has been for the past eighteen years a member of the Division of Agronomy and Plant Genetics at the university.

DR. WENDELL F. HESS, head of the welding laboratory at the Rensselaer Polytechnic Institute, has been promoted to a professorship of metallurgical engineering.

IT is reported in *Nature* that the Association of British Zoologists, which owing to the war had not met since January, 1939, held its tenth annual general meeting on March 24 in the rooms of the Zoological Society of London. Professor James Ritchie was elected president and Dr. John Smart, British Museum (Natural History), London, was elected honorary secretary.

DR. H. S. SOUTTAR, consulting surgeon to the London Hospital and formerly chairman of the council of the British Medical Association, has been elected president of the association in succession to the late Lord Dawson. He has also become manager of the Royal Institution, London.

THE retirement is announced of Sir Edward B. Bailey, D.Sc., F.R.S., director of the Geological ... vey of Great Britain.

DR. J. E. WALTERS, professor of personnel ... ministration at Purdue University, has been el... president of Alfred University, New York.

DR. EDMUND GIFFEN, since 1940 director of ... search at the British Institution of Automobile E... neers, has been appointed to the chair of civil ... mechanical engineering of the University of Lon... tenable at Queen Mary College.

BRAYTON EDDY, administrator of entomology ... plant industry for Rhode Island, has been na... curator of insects and of reptiles at the New Y... Zoological Park. The late Dr. Raymond L. Ditm... was in charge of reptiles for more than forty ye...

DR. ALEXANDER N. WINCHELL became emeritus p... fessor of geology of the University of Wisconsi... the end of May, 1944. Since then he has served ... consultant for industrial research laboratories ... Louisville, Ky., Neenah, Wis., Cincinnati, O... Niagara Falls, N. Y., and Cleveland, Ohio. On ... 1 he accepted a position as resident consultant to ... American Cyanamid Company at Stamford, C...

A GRANT of $6,000 has been made by the C... Products Research Foundation to the University ... California in aid of the researches of Dr. W. ... Hassid on the chemistry of starch and other car... hydrates.

DR. ANTON J. CARLSON, emeritus professor ... physiology of the University of Chicago, gave ... May 28 the annual address of the Chapter of ... Society of Sigma Xi of the University of Cincinn... His subject was "Footnotes on the Core of Scie... in Liberal Education."

PROFESSOR EDWARD KASNER, of Columbia Univ... sity, gave on May 16 before the forum of the Scri... Mathematica a lecture on "Mathematics in Hol... wood."

DR. HUDSON HOAGLAND, executive director of t... Worcester Foundation for Experimental Biology, ... June 3 made the address at the one hundred a... twenty-fourth commencement of Colby College.

IN connection with the fourteenth refresher cou... of the Canadian Medical Association at the Univers... of Alberta, Edmonton, held from May 7 to 11, Colo... Richard Pearson Strong, director of tropical me... cine, Army Medical School, Washington, D. C., d... livered three lectures on "Tropical Diseases in R... lation to the Present War."

DR. WALTER V. BINGHAM, chief psychologist in t... Classification and Replacement Branch of the W... Department, gave an address on "Psychology and t...

War" before the Canadian Psychological Association during its annual convention which was held in Montreal on May 28 and 29. Presiding was Colonel William Line, of the University of Toronto, who is serving with the Canadian Army as director of personnel selection.

THE G. J. Symons Memorial Lecture of the Royal Meteorological Society was delivered on April 18 by G. E. R. Deacon. The title of his lecture was "Water Circulation and Surface Boundaries in the Oceans."

THE two hundred and sixty-sixth meeting of the American Physical Society with limited attendance at the Ohio State University was held on June 15 and 16. It included the second annual meeting of the Division of Electron and Ion Optics of the society, and a group of invited papers on biophysics, arranged by Dr. Detlev W. Bronk, Johnson professor of biophysics at the University of Pennsylvania. This meeting was held under the regulation of the Office of Defense Transportation limiting attendance to people living in Columbus and its local commuting zone and to not more than fifty coming from elsewhere.

A CONFERENCE of the Arts, Sciences and Professions in the Post-War World will be held on June 22 at the Waldorf-Astoria Hotel, New York City, under the auspices of the Independent Citizens' Committee of the Arts, Sciences and Professions. Dr. Harlow Shapley, director of the Harvard College Observatory, is chairman of the conference. Subjects to be discussed in the Science and Technology Panel are the discovery and development of science talent in American youth; the role of science in the development of regional resources; science opens up production; and post-war research possibilities. Professor Paul Sears, of the department of botany at Oberlin College and government consultant on agricultural problems, will speak on regional resource development. The problems of developing social talent will be discussed by Lieutenant Steuert Henderson Britt (USNR), formerly director of the Office of Psychological Personnel of the National Research Council. Professor Walter Rautenstrauch, of the department of industrial engineering of Columbia University, will discuss the relationship between science and industry.

THE seventh annual summer conference of the New England Association of Chemistry Teachers, to be held at Massachusetts State College, Amherst, on August 9 to 13, will be in the form of a symposium on chemical equilibrium.

A CONFERENCE on industrial ophthalmology, in cooperation with the National Society for the Prevention of Blindness, was held by the College of Physicians and Surgeons of Columbia University from May 7 to 11. Representatives of forty-seven four-year medical schools were represented at the conference, in addition to the representatives of various government agencies.

A CONFERENCE of a few research workers interested in the application of carbon isotopes to the study of biochemical problems is to be held on June 19 and 20 at the Lankenau Hospital Research Institute in Philadelphia. The meeting will be devoted to discussion of the present and future application of carbon isotopes in biochemical studies, as well as of their methods of concentration and measurement. Those interested are cordially invited to attend. Further details may be obtained by writing to Dr. Stanley P. Reimann, director, Lankenau Hospital Research Institute, Philadelphia 30.

ACCORDING to the will of the late Fred K. Hinchman, the Southwest Museum will receive a bequest, the income from which will provide, among other things, storage cabinets for the study collections of the museum. Mr. Hinchman, for many years supervisor of education extension, also left to the museum his extensive Indian collections and his anthropological library.

ACCORDING to *The Experiment Station Record*, a ten-year agreement signed on July 15, 1944, by the Governments of the United States and Guatemala provides for cooperation in establishing and operating an agricultural experiment station in Guatemala to promote the cultivation of cinchona in the Western Hemisphere. The general functions of this station include not only investigations necessary to establish and maintain a permanent cinchona industry in Guatemala, but, if found desirable, to carry on agronomic production investigations on other complementary crops. Cooperation is provided in the establishment of approved agricultural practices and the propagation of planting materials and in the promotion of tropical agriculture in cooperation with other agricultural institutions and official agencies in the Western Hemisphere. The Government of Guatemala will provide land, laboratory and office space, tools, office, field and laboratory assistants and unskilled labor, and at least one assistant to cooperate with each investigator detailed to the station by the United States. The United States agrees to provide a scientific staff to direct the station and conduct its investigations, publication facilities, scientific equipment and land motor vehicles if available. The scientific staff is empowered to assist in the work-training programs of the students approved by the Guatemalan School of Agriculture for studies on scientific problems. The agreement runs for ten years, unless one party fails to provide funds.

EQUIPMENT for a National Institute of Physiology in China, devoted entirely to the study of developmental physiology, is now being purchased in the United States by its future director, Dr. S. C. Shen,

who is working in the Highpolymer Research Bureau of the Polytechnic Institute of Brooklyn. He is in this country as a representative of the Ministry of Education of the Chinese Government. After the war the new institute will be in Shanghai, since it is considered advisable to have it near a seaport. Dr. Shen plans to take an ultracentrifuge back with him and is now purchasing basic equipment which is being shipped out as rapidly as possible. The first project will be an investigation of the nutrition status of Chinese children with a view to improving the content of foods with essential minerals and vi mins. Since going to the Polytechnic Institute t year, Dr. Shen has been collaborating with Dr. K G. Stern, who is working with Dr. Herman F. Ma director of the bureau, under a grant from the Car S. Scheuer Foundation of New York, on the appli tion of the ultracentrifuge to highpolymer chemist

DISCUSSION

ANTHONY ASKHAM, THE AUTHOR OF THE VOYNICH MANUSCRIPT

IN 1912, in an Italian monastery, the late Wilfred M.Voynich found a manuscript which some of the world's best cryptographers have called undecipherable. Recently I have found the key and some of the details, including the name of the author and the language used, which are here presented for the first time.

The dating of the Voynich manuscript beyond 1493 by O'Neill,[1] restricts considerably the search for the key to the cipher. This determination of a date is based upon the inclusion in "the most mysterious manuscript in the world" (Manly[2]) of the common sunflower, *Helianthus annuus* L., and the pepper plant *Capsicum,* two plants, native to the Americas, which were unknown to Europeans before the return of Columbus from his second voyage. Recently, this key has been determined and some of the biological material contained in cipher has been decoded. Due, however, to present war conditions, it seems undesirable to publish, at this time, the details of the key.

The peculiar use of a double system of arithmetical progressions of a multiple alphabet indicates that the author of the Voynich manuscript was familiar with the ciphers discussed by Trithemius,[3] Porta[4] and Selenius.[5] It is not wise to date a manuscript based upon the dates of these published works, since the material is known to have been circulated in manuscript for many years. The format and use of certain peculiar symbols (mirror images of the Italian d or di and el, respectively) are evidences that the author was probably familiar with the manuscript of Leonardo da Vinci's "Anatomy"[6] (written about 1510). The symbols used in the Voyni indicate, however, origins from many and unkno sources. The text, so far decoded, is in Medie English and deals with (1) the effects of plants physiological processes in health and disease, esp cially, the diseases of women, and (2) a conceptio of pre-Harveian[7] generation and parturition. As illustration, the following description of the birth an infant was decoded from folio 78: "When sku uf tun'e-bag rip, seo oogon kum sli of se mosure-iss ped-stans sku-bent, stokked kimbo-elbow crawknot That is, put into modern English this passage b comes, "when the contents of the womb rip (or te the membranes), the child comes slyly from t mother-issuing with the leg-stance scewed anu be while the arms, bent at the elbow, are knotted (abo the head) like the legs of a crawfish." Among t many examples of the effects of plants on human b ings, several references to the use of antibiotics ha been determined from the decoded material. Fro folio 93, was decoded, as the author of the manu script, the name of Dr. Askham. On several previou occasions the opinion has been expressed that t manuscript was written in Latin by Roger Bacon.

According to the "Dictionary of National Biogra phy," Anthony Ascham (older spelling Askham), 1553, astrologer) studied at Cambridge, became M.B in 1540, and in 1553 was presented by Edward VI t the vicarage of Burneston, Yorkshire. He is probabl to be identified with Anthony, the brother of Roge Ascham.[8] Anthony Ascham wrote several almanacs, "Treastise on Astronomy" and more especially " Little Herbal, etc.," 1550. The author has been unabl to study the herbal yet. Larkey and Pyles,[9] however state that in comparison with other writers of herbal published about this time (Banckes, 1525, etc.), Asch am refers to a very large number of the diseases o women.

[1] Hugh O'Neill, *Speculum,* 19: 126, 1944.

[2] John Matthews Manly, *Speculum,* 6: 345, 1921.

[3] Johannes Trithemius, Steganographia, 1551 (?); Polygraphia, 1518.

[4] Joan Baptista Porta, De Furtivis notis vulgo. De Ziferus Libri IIII. 1563.

[5] Gustavi Seleni, Cryptomenytices et Cryptographiae Libri IX. 1624.

[6] T. Sebachnikoff, "I Manoscritti di Leonardo da Vinci della reale Biblioteca di Windsor"; "Dell' Anatomia." Parigi. Rouverge Fogli A. Torino. Viarengo. Fogli B. 1898 and 1901.

[7] Wm. Harvey, "Exercitationes de generatione ani malium." London: W. Dugard. 1651.

[8] Grant, Vita Aschami in Ascham's works et Giles IV 307.

[9] S. V. Larkey and T. Pyles, "An Herbal" [1525], 1941, footnote p. xix.

In view of the facts (1) that the Voynich manuscript deals in part, at least, with the history of medical thought of the sixteenth century and (2) that the key already determined gives a consistent and connected sequence of decoded material based upon the rules of mathematics, the hope is expressed that the complete manuscript (or a photostatic copy of same) may be made available to the author for present use thus making inappropriate any attempt at accusing an honest decoder of the use of "a learned and ingenious subconsciousness").[2]

LEONELL C. STRONG
YALE UNIVERSITY SCHOOL OF MEDICINE

THE GENETIC ASPECTS OF THE ENZYME-VIRUS THEORY OF CANCER

WHEN investigators in widely separated fields arrive at substantially the same conclusions regarding a common point,[1,2] it is not only a significant event but also a time to pause and inquire whether the departmental barriers—evidenced by terminology—may not have outlived their usefulness. At the very least it is necessary to inquire whether the various specialists may not be coining words which designate the same entities.

To trace the parallel advances which have been taking place in cytology, virology, enzymology and genetics prior to the actual application of these findings to the cancer problem would be a task to which the writer does not pretend to be equal. These developments reach common ground, however, in the fundamental work of Claude,[3] who showed that certain particulate components in cytoplasm, called mitochondria and microsomes, are ribonucleoproteins. The writer has for some time been developing methods for the extracellular study of these particles as enzymes,[2,4] that is, in terms of the chemical reactions which they promote. These techniques have been employed by Claude[5] to show enzyme activity in the collected particles, and attempts have been made to see whether the enzymes are to be identified with the particles.[6]

Meanwhile momentous advances in the field of genetics provide an explanation for non-Mendelian inheritance in terms of extra-nuclear entities[7,8,9,10,11,12] which are variously referred to as plasmones, plasmagenes, plastogenes, factors, influences or enzymes. Darlington[13] and Haddow[14] have recently brought together the many observations in the field of genetics and virology which suggest the possible identity of some of these particles. Indeed, these writers, who are in substantial agreement, regard a "virus" as a "plastogene" in the wrong place. This recalls the writer's view that a virus is an "outlaw" enzyme[15] and that "life began when a small group of enzymes became organized for mutual benefit."[16] The writer's enzyme-virus theory of cancer[1,2] proposed that cancer was mainly the result of competition between two autosynthetic proteins: a normal enzyme protein *vs.* a cancer protein lacking certain specific catalytic properties possessed by the competing normal protein. The cancer protein could be the end result of a variety of processes: it could arise spontaneously as a result of a mutation or be produced by the action of carcinogenic chemicals, or be introduced preformed as a virus. By assuming that the cancer protein, regardless of how it was formed, was the bearer of the changed enzymatic activities which the writer observed in cancer tissue as contrasted to normal tissue, it was possible to construct a theory which would integrate most of the important facts about cancer, as well as to formulate the stages of cancer development.[17] It is now of interest to find that both Darlington and Haddow, evidently without having access to the writer's contributions from the enzyme side, have come forward with a concept of cancer which is based upon the idea of cancer proteins of diverse origins but characteristic properties, *viz.*, "These viruses [referring to the Rous tumor virus and the Bittner milk agent] are distinguished from plasmagenes not by their origin or action but only by their transmission. There is therefore nothing surprising in the fact that reproductive particles can suddenly appear in the cytoplasm by the action either of the mutafacient nucleus or of external carcinogens, nor again that such particles may either be transmissible or only transplantable."[13]

It is noteworthy that while the above view was not based upon enzyme studies, neither was the writer aware of the wealth of data which the English writers presented. The illuminating discussions by Darlington and by Haddow contain nothing which weakens the enzyme-virus theory and much which strengthens it. Conversely, the enzyme-virus theory may provide

[1] V. R. Potter, *Cancer Research*, 3: 358, 1943.
[2] *Idem*, *Advances in Enzymology*, 4: 201, 1944.
[3] A. Claude, SCIENCE, 91: 77, 1940.
[4] V. R. Potter, *Jour. Biol. Chem.*, 141: 775, 1941.
[5] A. Claude, *J. Exp. Med.*, 80: 19, 1944.
[6] V. R. Potter and H. G. Albaum, *Jour. Gen. Physiol.*, 26: 443, 1943.
[7] J. J. Bittner, SCIENCE, 84: 162, 1936.
[8] M. Rhoades, *Proc. Nat. Acad. Sci.*, 29: 327, 1943.
[9] T. R. Sonneborn, *Proc. Nat. Acad. Sci.*, 29: 329, 1943.
[10] *Idem*, *Proc. Nat. Acad. Sci.*, 29: 338, 1943.
[11] S. Spiegelman, C. C. Lindegren and G. Lindegren, *Proc. Nat. Acad. Sci.*, 31: 95, 1945.
[12] S. Spiegelman, *Ann. Missouri Bot. Garden*, 32: 139, 1945.
[13] C. D. Darlington, *Nature*, 154: 164, 1944.
[14] A. Haddow, *Nature*, 154: 194, 1944.
[15] V. R. Potter, *Jour. Am. Diet. Asn.*, 19: 488, 1943.
[16] *Idem*, *Jour. Am. Diet. Asn.* 18: 359, 1942.
[17] *Idem*, SCIENCE, 101: 105, 1945.

some of the "passwords" which will take us across the "technical and arbitrary . . . frontiers that exist between the studies of heredity, development and infection."[11] That these frontiers are already being crossed by means of enzyme techniques is apparent from the work of Spiegelman and Lindegren[11,12] who have shown that the melibiose-fermenting enzyme in yeast could be maintained and reproduced in the *absence* of the gene necessary for its *initial* synthesis. Thus we have an example of the autosynthesis which forms the basis of the competition between enzyme X and cancer protein in the enzyme-virus theory of cancer.

The novelty of the writer's theory of cancer does not lie in its use of the word virus. There was already a virus theory of cancer, just as there was an irritation theory, a genetic theory, a hormone theory and many others. However, the individual theories did not explain the facts which were used to support the alternate theories. The final theory must satisfy not only the biologist, but also the chemist and physicist; it must explain all the facts and in so doing will be not only a theory of cancer but a theory of life.[2] The keystone in the whole structure appears to be the identity or non-identity of the enzymes (*sic*) with the terms used by the other specialists. That is, each genetic factor not only produces a character in an ultimate time-space continuum that can be recognized visibly by the biologist, but it must also produce a chemical reaction that is recognizable here and now on a chemical basis. The need in this work is not for interpreters but for specialists who are at least "bilingual." In the latter case we naturally emphasize the importance of the language of the enzymologist.

VAN R. POTTER

McARDLE MEMORIAL LABORATORY,
UNIVERSITY OF WISCONSIN MEDICAL SCHOOL

THE EFFECT OF OXALATES IN THE DIET

IN the March 16 issue of SCIENCE Roe E. Remington and Cecil L. Smith give superficial observations on feeding a commercial preparation (spintrate) and attempt, without basis, to throw new light on the effect of spinach in the diet. At the same time, they give a wrong impression of the established and published data of Fincke and Sherman which they cite[1] and of others[2] which they ignore, regarding the occurrence of oxalic acid and its effect on calcium utilization, by the following statement: "Since it has been reported that there is some substance, *presumably oxalic acid,* (italics not theirs) which interferes with the utilization of calcium for bone formation. . . . "

The occurrence of oxalic acid and oxalates in spinach (and in other foods) is not on a "presumptive" basis, as any one who is versed in food chemistry well knows. That the oxalates in spinach have no effect on rat growth or bone formation, if the diet contains adequate calcium to stoichiometrically match the oxalate in addition to the normal calcium requirement, has been fully demonstrated, as Remington and Smith could have ascertained if they had familiarized themselves with the literature.

By not going to the trouble even to give the oxalate and calcium contents of their diet they have presented confusion, not enlightenment. If "spintrate" represents dehydrated spinach, it is likely that it has been blanched, since that is the usual practice in dehydrating vegetables. In that case the oxalates other than calcium oxalate, because of their solubility, are largely extracted, as are other water-soluble components, and the remaining calcium oxalate is practically inert. As an average figure the calcium oxalate in spinach constitutes only about one third of the oxalate content.

EDWARD F. KOHMAN

CAMPBELL SOUP COMPANY,
CAMDEN, N. J.

"ANGRY" MOSQUITOES

A REPORT by Kahn, Celestin and Offenhauser recently published in SCIENCE[1] contains some very interesting and potentially significant observations regarding the sounds produced by mosquitoes. The data concerning species differences, sex differences and effects of interindividual stimulation are particularly instructive.

Inasmuch as the authors indicate their intention to continue their investigational program, and therefore presumably to publish more extensively, it may not be amiss to enter a plea for more careful and objective treatment of the psychological phenomena involved. In the article under consideration it is suggested that the calls of mosquitoes "may be in the nature of (a) mating calls, (b) calls warning of danger, (c) calls of anger and other sounds that are similarly functional."

Serious students of animal behavior have long been aware of the dangers of interpreting the reactions of a lower species in terms of psychological experiences characteristic of human beings. The facile process of imputing human motives and feelings to other forms and thus "explaining" observed behavior is rightly discouraged.[2] Such a procedure necessitates certain assumptions which are rarely made explicit, and are often unrecognized even by their author. To

[1] M. L. Fincke and H. C. Sherman, *Jour. Biol. Chem.*, 110: 421, 1935.

[2] B. W. Fairbanks and H. H. Mitchell, *Jour. Nutrition*, 16: 79, 1938; F. F. Tisdall and T. G. H. Drake, *Jour. Nutrition*, 16: 613, 1938; E. F. Kohman, *Jour. Nutrition*, 18: 233, 1939.

[1] M. C. Kahn, W. Celestin and W. Offenhauser, SCIENCE, 101: 335, 1945.

[2] T. C. Schneirla, *Jour. Comp. Psychol.*, 34: 79, 1942.

gnate a particular sound produced by a mosquito "call of anger" is to imply a parallelism between psychological processes of the insect and those of an who is angry. Whether or not the inference is ntional is immaterial. The psychologically naive ier will unconsciously assimilate it as part and el of the presentation and accord it weight equal hat given the objective data with which it is asso-ed.

The objections to anthropomorphic interpretations nimal behavior are several. (1) As noted above, involve the implicit, but infrequently stated as-ption of close similarity between psychological esses in widely separated species. (2) They sub-ute a process of naming for one of analysis. Thus labelling of an act as an expression of anger, of or of mother love is sometimes regarded as suffi-t explanation of the overt response. In actuality explanation whatsoever has been advanced. (3) riously enough anthropomorphic interpretation is t often applied to forms of behavior which are best only dimly understood in man himself. A at deal of hard work has been and is being done an attempt to elucidate the stimuli, the mediating chanisms and the overt expressions involved in man emotions; but the most ardent student of the bject would be quick to admit that we are a long y from a satisfactory understanding of the func-ns involved. This being the case, one is clearly advised to attempt to interpret the reactions of er animals in terms of human emotions.

It is to be earnestly hoped that the investigation sounds produced by mosquitoes will be pushed ead, and the resultant findings will be published. e may be certain that the physical characteristics of e calls recorded will be expressed in recognized antitative terms such as cycles per second, etc. This te is to ask that the behavioral features of the phe-mena be accorded equally objective treatment.

FRANK A. BEACH
DEPARTMENT OF ANIMAL BEHAVIOR,
AMERICAN MUSEUM OF NATURAL HISTORY

RESSURE DUE TO MOUNTING SCIENTIFIC KNOWLEDGE

THE number of fields of science have increased to ch an extent that it has become impossible for any e man to become conversant with all of them. Some the sciences have so developed that it has become ficult, if at all possible, to master a single one of em in its entirety.

As the frontiers of a scientific field expand and ecede from the regions covered by experience, the ientific explorer is forced to spend more and more ars in getting to the frontier. Unless some radical easures are taken, this situation will soon become so ggravated as to put a brake on the progress of science and force the scientist to become a specialist in an ever narrowing field.

Evidently the remedial measures should aim at securing time-saving means of acquiring knowledge and more efficient use of those means. To this end I suggest, first, making English the international second language for science; second, making English completely phonetic; and third, streamlining and otherwise improving our educational procedures.

In a recent communication, Professor Duane Roller[1] called attention to the need of an international second language for science; he referred to the advantages of English; and suggested that Basic English be used in our scientific periodicals in order to make English the international second language.

No one questions the need for an international second language. Many recognize the advantages of English over other languages, natural or artificial, especially from the point of view of practicability. But few would concede either that Basic English is adapted to the needs of science or that its use in our periodicals could make English an international second language.

Basic English is designed to convey simple ideas. It is not adapted to the expression of the relatively complex ideas of science. Furthermore, the advantage of Basic English is due to its limited vocabulary. This would be largely cancelled by the addition of the extensive technical vocabulary of science.

It is true that simplicity of expression is helpful to all readers, native as well as foreign. But that alone is not sufficient to make English an international language. However simple scientific English is made, a Frenchman will still have to learn Russian if he wants to read scientific papers published in Russian.

English could become the international second language for science if every important research paper written by the scientists of the world were published in English. This could be done if sufficient funds were made available to the scientific societies of the English-speaking countries to enable them to translate and to publish every important research paper submitted by scientists of other countries.

The amount of money required for putting such a plan into effect would be great indeed; but the benefits derived would be even greater—English-speaking scientists would be relieved of the burden of having to learn foreign languages; other scientists would have to learn only one foreign language. Even from a purely financial point of view, the execution of this plan might prove to be a good investment, for the simple reason that the foreign trade of the English-speaking countries would be given a great impetus.

English spelling is not only a stumbling block to

[1] Duane Roller, SCIENCE, 101: 299, 1945.

foreigners, but consumes a great deal of the time of English-speaking children and an appreciable amount of the nervous energy of adults. If a sufficient number of letters were added to the alphabet to make English completely phonetic, much time and energy could be saved for all concerned.

For streamlining and otherwise improving our educational procedures, I suggest:

(1) Elimination of the requirement of every subject in the school curriculum which is not indispensable. Foreign languages, dead or living, for example, are not indispensable as required subjects. It is not necessary to read a book in the original language in order to become effectively acquainted with its contents. It is true that the "flavor" peculiar to the original language is lost in translation. But its price in terms of time has become too high for the majority of students.

(2) Elimination from text-books of every topic which is not indispensable to further progress in the subject or which could be treated more effectively in advanced texts. The methods for finding square roots of numbers and the distance from a point to a line, which are given in text-books on arithmetic and analytics, are cases in point. These highly special methods are not necessary to the student for further progress in the subjects, and their purposes are better served by the more general methods of logarithms and of maxima and minima.

(3) Improvement of the order in which subjects appear in the school curriculum in order to secure better timing and to bring into play the pupil's interest and incentive.

(4) Teaching of the physical and biological sciences continuously from kindergarten through high school. Somehow the natural curiosity of the child is being destroyed and the common sense of the pupil is being bred out of him, as applied to his studies. The teaching of science continuously in primary and secondary schools would help correct these conditions. The elements of science interest children. Science deals with the tangible and the concrete; therefore it is well adapted for training children to make use of their common sense in their studies.

In colleges and universities, the majority of students avoid science courses whenever possible, because they find them difficult. As a result, most of our leaders in education, in religion, in industry and in other controlling fields are generally ignorant of science and of the scientific method of approach to problems of life; they are untouched by the scientific spirit. Most of the major ills of our age can be ascribed to this cause.

If science were taught continuously throughout the school years, college freshmen would be familiar with many of the scientific terms and concepts. Co quently they would not find college courses as diffi as they do now.

(5) Greater use of the laboratory method in sc science. The laboratory method could be introdu even in the lowest grades. In teaching the multi cation table, for example, the child could be asked place blocks in rows and columns of 4 and to co the resulting number of blocks. Thus he could only discover that $4 \times 4 = 16$, but he could also helped to see that multiplication is a short cut repeated addition of equal numbers. He could the same time learn what the square of a number the area of a square mean.

(6) Greater use of the historical and philosophi approach to scientific subjects in college. The coll student may now take a course in the calculus with knowing the problem which led Newton to the disc ery of the method of the calculus. He may go thro a course in physics without learning how Galileo h pened to come to the concept of inertia. He m major in a science, yet may not know what is me by the scientific method.

(7) Placing greater emphasis on understandi general principles and on learning general metho Some text-books are more in the nature of hand-boo than text-books. Trigonometry books are about worst in this respect. Some of them give three, ev six, formulas to express the Cosine Law, when o would be sufficient. Most of them give dozens formulas for the functions of large angles, when simple rule is all that is needed. Most mechan books, on the other hand, make the subject appe unnecessarily complicated, by classifying forces in a large number of types and giving them differe names. Problems may be classified into types, b forces can not be so classified, because the lat have no types. Furthermore some of the names giv are patently absurd—for example, "imaginary," "f titious" and "lost" forces.

It is not necessary to extend this list any furth The important point I want to stress is this: The is a crying need and a great opportunity for creati conditions which would make it possible for the futu scientist to reach the frontiers of his specialty earli in life and at the same time to obtain a broader ed cation.

H. M. Dadourian

Trinity College,
Hartford, Conn.

THE SHORTAGE OF SCIENTIFIC PERSONNEL

Much has been said[1] about the scarcity of traine

[1] M. H. Trytten, *The Scientific Monthly*, January, 194 p. 37.

scientific personnel. Continued military research as well as the great peace-time industrial undertakings on the horizon will together demand more technologists than have ever been available, and this at a time when we have allowed our scientific personnel resources to dwindle seriously. This promises to become one of our large post-war problems. The promotion of the general technological welfare is at stake.

Anything that can be done, no matter how small, to accelerate the reaccumulation of this important human resource is worth doing and should be done.

Several efforts are now under way to encourage the return of young scientists and others to school. The encouragement being given veterans to return to school has been given wide publicity. The American Council on Education has facilitated the academic recognition of military in-service training through their evaluation[2] of large numbers of military training programs. Although the effect of these efforts should be great, they do not particularly stress the training needs in science and technology.

Recently, the National Research Council announced[3] a plan for granting fellowships for competent young scientists to study toward the doctorate. This will be an important step toward replenishing the supply of scientific personnel.

Another step would be to enlarge the opportunities for young scientists to continue their training on a part-time basis. This is something that can be done at once without waiting for the cessation of hostilities and the release of scientific workers from their present jobs. At the present time, a graduate student wishing to carry on his studies must look to local part-time educational facilities. Although the Office of Education's E.S.M.W.T. courses have been of considerable service, this student must usually look to evening classes at the nearest university. These facilities are frequently meager and inconveniently situated. Although there may be a wide choice of evening classes from a liberal arts standpoint, the choice in technological subjects may be slight and primarily at an elementary level. Furthermore, the campus on which these courses are given may be far from the place of employment of the student, and with long working hours and with overcrowded or slow transportation facilities the obstacles to this student taking the course he needs become very great.

In order to facilitate the attendance of these scientific personnel at the courses they need, it is proposed that universities and institutions employing scientific personnel together make a concerted effort to provide the courses needed at a convenient place. It would be necessary to find out what courses are needed by the employees of particular institutions and then to provide these courses at a convenient time and place—say, within the institution immediately after working hours. The students would then register with the university just as if the course were given on the campus.

Students who are able to pursue their studies on a part-time basis now are more likely to return to university campuses to complete their graduate requirements when the time comes for them to leave their present jobs. Not only would the students and universities benefit, but in the long run the institution would also benefit through the increased competence and value of their employees.

PHILIP N. POWERS,
Training Director

NAVAL ORDNANCE LABORATORY,
WASHINGTON, D. C.

SPECIAL ARTICLES

CRYSTALLINE REINECKATES OF STREPTOTHRICIN AND STREPTOMYCIN

STREPTOTHRICIN, the antibiotic agent produced by *Actinomyces lavendulae*,[1, 2, 3, 4, 5] and streptomycin, a closely related substance from *Actinomyces griseus*,[5,6,7,8,9] have been intensely studied recently in view of their possible utility for the control of infections resistant to penicillin. As a result, both substances have been characterized with regard to their antibacterial spectra, protective and toxic effects and other biological properties. However, published information concerning their chemical nature is scant and is in essence confined to the statement that they are both water-soluble bases; as to purification methods, only the preparation of crude concentrates has been described.[1, 6]

[2] American Council on Education, "Guide to the Evaluation of Educational Experiences in the Armed Services."
[3] SCIENCE, March 30, 1945, p. 322.
[1] S. A. Waksman and H. B. Woodruff, *Proc. Soc. Exp. Biol. and Med.*, 49: 207, 1942.
[2] J. W. Foster and H. B. Woodruff, *Arch. Biochem.*, 3: 241, 1943.
[3] G. Rake, D. M. Hamre, F. Kavanagh, W. L. Koerber and R. Donovick, *Jour. Med. Sci.*, 1945.
[4] H. J. Robinson and D. G. Smith, *Jour. Pharm. Exp. Therap.*, 81: 390, 1944.
[5] A. Schatz and S. A. Waksman, *Proc. Soc. Exp. Biol. and Med.*, 57: 244, 1944.
[6] A. Schatz, E. Bugie and S. A. Waksman, *Proc. Soc. Exp. Biol. and Med.*, 55: 66, 1944.
[7] D. Jones, H. J. Metzger, A. Schatz and S. A. Waksman, SCIENCE, 100: 103, 1944.
[8] H. J. Robinson, D. G. Smith and O. E. Graessle, *Proc. Soc. Exp. Biol. and Med.*, 57: 226, 1944.
[9] R. Donovick, W. L. Koerber and G. Rake, to be published.

We have succeeded in isolating from submerged culture filtrates of the respective *Actinomycetes* both streptothricin and streptomycin in form of their crystalline salts with Reinecke acid, which are antibiotically active in proportion to their content of the base component.

STREPTOTHRICIN

A mere outline of the procedure employed by us for the purification of streptothricin will have to suffice here. In brief, it involves absorption of the active principle on charcoal followed by elution with dilute mineral acid essentially as described by Waksman and Woodruff,[1] precipitation with phosphotungstic acid, conversion of the bases liberated from the phosphotungstate into a crude picrate and fractionation of the latter by chromatographic methods. One or more of the resulting fractions, after removal of the picric acid, yielded water-soluble amorphous products possessing a potency of 400–500 units[10] per mg. Addition of Reinecke salt, $NH_4[Cr(SCN)_4(NH_3)_2]$, to an aqueous solution of such highly active fractions resulted in the formation of crystalline precipitates, from which pure streptothricin reineckate was secured by fractional crystallization.

Streptothricin reineckate crystallizes in form of clusters of fine platelets which decompose at 192–194° (corr.) after sintering at 184°. Its potency was determined in repeated tests as 256 units per mg. The antibiotic activity of the salt is entirely due to its base component, as the ammonium salt of Reinecke acid in comparable concentrations is completely devoid of bacteriostatic properties.

The analytical composition of preparations isolated from two different fermentation batches, after drying *in vacuo* at 70°, was as follows: C, 25.0, 24.9; H, 3.94, 4.3; N, 23.8, 24.2; Cr, 10.54, 10.1; S, 25.8, –; H_2O loss: 4.1, 4.1. The analyses of two other independently prepared specimens fell into the same range.

These data suggest an empirical formula, $C_{21}H_{39}O_7N_{17}S_8Cr_2$ (calc: C, 25.19; H, 3.93; N, 23.76; S, 25.56; Cr, 10.38), which corresponds to the di-reineckate of a base $C_{13}H_{25}O_7N_5$.[11] We wish to make it clear that the formula for the free base, though it is supported by confirmatory evidence given below, should be regarded as provisional, since the molecular weight is not known.

Decomposition of several specimens of the reineckate with silver sulfate yielded streptothricin sulfate in form of an amorphous white powder which consistently assayed 500–530 units per mg. (calc. for streptothricin sulfate from the reineckate: 650 units per mg). The biological assay and elementary analysis of such preparations are rendered uncertain by their high water content (about 7 per cent.), pronounced hygroscopicity after drying, the presence of some free base and contamination by small amounts of break-down products of Reinecke acid, namely, chromium sulfate (about 2.5 per cent.) and ammonium sulfate (up to 7 per cent.). However, the analyses of three independently prepared specimens showed a C:N ratio of 13:5 (after correction for ammonia nitrogen), in good agreement with the above tentative formulation. Furthermore, they leave no doubt as to the high oxygen content of the base.

The α-amino nitrogen, determined by the manometric method of Van Slyke, was 20–22 per cent. of the total nitrogen (4 and 30 minutes reaction, both corrected for ammonium ion present). This finding supports the analytical evidence that streptothricin contains at least five nitrogen atoms, two of which are present as salt-forming basic groups. Streptothricin is free of O-methyl, N-methyl and hydrolyzable acetyl groups.

The ultraviolet absorption spectrum shows only end absorption, which rules out the presence of aromatic groups or other chromophores giving rise to specific absorption above 220 mμ.

Streptothricin is stable between pH 1 and 8.5, but is destroyed more or less rapidly by higher degrees of alkalinity. It gradually reduces Tollens' reagent and neutral permanganate solution in the cold, and Fehling solution immediately on boiling. It gives positive biuret and ninhydrin reactions, whereas the ferric chloride, nitroprusside, Molisch, Sakaguchi and Schiff tests are negative.

Attempts to secure other crystalline salts have been unsuccessful, nor has acylation of the basic group(s) with various aliphatic and aromatic acyl chlorides so far yielded any crystalline derivatives. All the acylated products are neutral, which indicates that there are no free acidic groups present in streptothricin. Some significant facts emerged from experiments in which benzoyl chloride was used as the acylating agent. When the reaction was carried out in aqueous bicarbonate solution, that is, under conditions favoring benzoylation of the basic groups only, a product was obtained which analyzes well for a dibenzoyl derivative of the base $C_{13}H_{25}O_7N_5$. (Found: C, 56.56; H, 5.82; N, 12.11. Calc. for $C_{27}H_{33}O_9N_5$: C, 56.74; H, 5.82; N, 12.25.) On the other hand, benzoylation in pyridine yielded what appears to be a penta- or

[10] The streptothricin unit referred to has been defined in previous publications (see references 2 and 3). The same unit has been adopted for the assay of streptomycin. Exchange of samples of streptomycin with Dr. S. A. Waksman showed that this unit corresponds very closely to his *E. coli* streptomycin unit.

[11] The absence of sulfur in streptothricin and streptomycin has been demonstrated qualitatively on partially purified preparations of the respective hydrochlorides.

hexabenzoyl derivative of a base of this composition. It may be inferred from these results that streptothricin contains 3 or 4 hydroxyl groups in addition to 2 acylatable basic groups.

Hydrolysis of streptothricin with hydrochloric acid has yielded two water-soluble bases in form of their crystalline picrates, on which we shall report in a separate communication.

STREPTOMYCIN REINECKATE

This compound was obtained from submerged culture filtrates[9] by a procedure similar in many respects to that employed in the isolation of streptothricin. It crystallizes from water in thin plates which decompose at 162–164° (corr.). Two preparations derived from different fermentation batches were analyzed after drying at 70° *in vacuo* (H_2O–loss: 6.1 per cent., 5.8 per cent.): C, 27.1, 26.9; H, 4.65, 4.31; N, 21.4, 20.8; S, 20.8, 21.2; Cr, 8.53, 8.27. The inconsistencies in some of the analytical figures preclude the assignment of a definite empirical formula at the present time. However, formulae $(C_{14}H_{26}O_7N_9S_4Cr)_n$ or $(C_{14}H_{26}O_8N_9S_4Cr)_n$, corresponding to $(C_{10}H_{19}O_{7-8}N_3)_n$[11] for the basic component, are in reasonable agreement with the above data and provide a basis for calculating the potency of free streptomycin. Since the two analyzed preparations of the crystalline reineckate assayed 370 and 410 units (10) per mg, respectively, it follows that the potency of the pure streptomycin base should lie between 800 and 910 units per mg. Decomposition of one of these preparations with silver sulfate yielded streptomycin sulfate assaying 850 units per mg.

We wish to acknowledge with sincere thanks the cooperation of Drs. G. Rake, W. Koerber, R. Donovick and D. Hamre, of the Division of Microbiology, who helped in the fermentation and purification procedures and furnished the numerous assay data required, and of Messrs. W. A. Lott and W. Braker, of the Division of Medicinal Chemistry, who directed some of the pilot plant operations involved.

J. FRIED
O. WINTERSTEINER
DIVISION OF ORGANIC CHEMISTRY,
SQUIBB INSTITUTE FOR MEDICAL RESEARCH
NEW BRUNSWICK, N. J.

CHRONIC INTERMITTENT ANOXIA AND IMPAIRMENT OF PERIPHERAL VISION[1]

IN general, the methods which have been employed in testing visual functions under conditions of acute anoxia have failed to reveal reliable signs of impairment below altitude pressures of 12,000 feet above sea level.[2] Comparable studies for possible effects of chronic intermittent anoxia have been lacking. With the great expansion of aviation in the present war, it became imperative to establish a sound basis for Service regulations governing the use of oxygen equipment on repeated missions. Twenty male subjects, selected to meet the age, physical and mental standards of the Service Air Corps, were exposed in a low pressure chamber to a simulated altitude of 10,000 feet above sea level for five or six hours per day, six days per week, for a period of four to six weeks. Before, during and after the period at altitude, peripheral vision was systematically studied in each subject by means of a newly developed, quantitative campimeter.[3]

During the third or fourth week of exposure at 10,000 feet, thirteen of the twenty subjects developed a marked and progressive impairment of peripheral vision. This impairment was reflected by failure to see targets briefly exposed in the peripheral field that had previously been readily detected. It occurred in some subjects without any associated alteration of central vision, although in others both functions were impaired. It developed insidiously in the sense that the subjects were unaware of it. Once established, it could not be relieved immediately by the inhalation of 100 per cent. oxygen at altitude and it could still be detected on the same day at ground level, although to a less marked extent. The effect was not immediately reversible in some subjects at the end of the four- or six-week period; in some instances days or weeks elapsed before return to preexposed levels of visual efficiency. One subject, who developed a very marked impairment of peripheral vision with delayed recovery, was reexposed nine months later. During the second exposure, however, he breathed 100 per cent. oxygen during the middle hour of each daily five-hour period at altitude. Under these conditions no impairment of peripheral vision occurred.

Four additional subjects were likewise chronically exposed to a particular altitude ranging from 11,500 to 18,000 feet. In these individuals the impairment of peripheral vision appeared earlier, was more marked and was recovered more slowly as the altitude, or the degree of anoxia, was increased. These subjects were studied by Bryan and Ricketts[4] in their search for possible effects upon the adrenal cortex of chronic intermittent anoxia. They were maintained

[1] The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Chicago.

[2] H. G. Armstrong, "Principles and Practice of Aviation Medicine," second ed. Chapter xviii. Baltimore: Williams and Wilkins Co. 1943.

[3] W. C. Halstead, *Arch. Neurol. and Psychiat.*, 52: 252, 1944.

[4] A. H. Bryan and H. T. Ricketts, *Jour. Clin. Endocrinol.*, 4: 450, 1944.

on constant, weighed diets, and careful metabolic technique was followed throughout. Studies were made of glucose tolerance, urinary excretion of sodium, potassium, chloride, phosphorus, nitrogen and 17-ketosteroids. With the possible exceptions of a slight increase in potassium excretions in two subjects, a transient rise in 17-ketosteroid excretions in one subject and moderate decrease in tolerance for glucose in two, the findings pointing towards changes in the adrenal cortex were negative. Since all these subjects developed an impairment of peripheral vision at altitude, there would seem to be no relationship suggested between the alteration in peripheral vision and any of the variables studied by Bryan and Ricketts.

Certain lines of evidence point to the cortex of the frontal lobes of the brain as the probable region involved in the alteration of peripheral vision described here. A similar impairment has been found to result from removal of one or both prefrontal lobes in neurosurgical patients studied in this laboratory, while the effect has not been found following unilateral removal of any other lobe of the brain.[5] The effect has also been found here to occur on a transitory basis following partial destruction of both frontal lobes in man by the operation known as lobotomy. In this connection it is of interest that Kennard[6] and others have found a temporary alteration of peripheral vision to be produced by localized lesions in the frontal lobe of the Macaque monkey.

In the present investigation, 65 per cent. of the subjects exposed to chronic intermittent anoxia of altitude pressures as low as 10,000 feet above sea level developed a marked impairment of peripheral vision. It seems clear that former Service regulations which specified the use of oxygen above this altitude did not provide an adequate margin of safety.

WARD C. HALSTEAD
THE OTHO S. A. SPRAGUE MEMORIAL INSTITUTE
AND DEPARTMENT OF MEDICINE,
UNIVERSITY OF CHICAGO

INHIBITION OF GROWTH OF MYCOBACTERIUM TUBERCULOSIS BY A MOLD PRODUCT[1]

A NUMBER of reports have been made on the effect of various antibiotic agents derived from molds and higher bacteria upon the growth of *M. tuberculosis in vitro* and in some instances on the inhibition of experimental animal tuberculosis.[2,3,4,5,6,7] The present investigation is concerned with the *in vitro* inhibition of the tubercle bacillus by another product obtained from an as yet incompletely identified mold, one of a group of Aspergillaceae under study at the present time. The mold was grown on a modified Czapek-Dox medium for 14 days, the medium filtered clear of mold and debris, acidified to pH 1–2 and extracted with ether. The active material was separated from the ether by 0.5 N NaOH. Concentration was accomplished by repeated ether-alkali extractions using decreasing quantities. The final alkali extract, representing a concentration of the production medium of from 50 : 1 to 300 : 1, was neutralized with 4 N HCl. A highly colored product was obtained. This was found to be soluble in water or alkali and insoluble in acid. The acid precipitate was readily soluble in ether, chloroform or ethyl acetate.

The rapidly growing non-pathogenic strain of *M. tuberculosis* var. *hominis* (American Type Culture Collection No. 607) was used to test the antibiotic activity of the preparation. A standard inoculum, when floated on the surface of Long's or Dorset's synthetic liquid medium and incubated at 37.5° C, shows rapid growth so that within 5 days a dense, crinkled pellicle covers the surface of the medium and extends up the sides of the test-tube for a height of about 0.5 cm. A series of test-tubes, 1 inch in diameter containing 5 ml of liquid medium, to which varying concentrations of extract were added, was inoculated with a standard fragment of pellicle obtained from a freshly growing culture. The tubes were incubated at 37.5° C for from 5 to 14 days and the variation in growth recorded daily. It was found that the inoculum failed to show any evidence of proliferation when the concentration ranged from 0.03 to 0.09 ml of extract per ml of liquid medium, depending upon the potency of the extract. Partial inhibition of growth, which was characterized by varying degrees of proliferation of the inoculum, was obtained in a range of 0.01 to 0.04 ml extract per ml liquid medium. Culture of the partially or completely inhibited inoculum which was still floating at the end of the test period, however, showed active growth when transplanted on solid media. In another series, inocula were submerged in liquid medium to which a quantity of extract had been added that was known to be sufficient to produce complete inhibition of growth of a floating inoculum. Controls consisted of submerged inocula in liquid medium to which no

[5] W. C. Halstead, *Proc. Asn. Nervous and Mental Disease*. Chapter xx. Baltimore: Waverly Press. In press.
[6] M. A. Kennard, *Arch. Neurol. and Psychiat.*, 41: 1153, 1939.
[1] From the Laboratories of the Hudson County Tuberculosis Hospital, Jesrey City, N. J., and The Mount Sinai Hospital, New York, N. Y.
[2] M. I. Smith and E. W. Emmart, *Pub. Health Repts.*, 59: 417, 1944.
[3] A. Schatz, E. Bugie and S. A. Waksman, *Proc. Soc. Exp. Biol. and Med.*, 55: 66, 1944.
[4] A. Schatz and S. A. Waksman, *Proc. Soc. Exp. Biol. and Med.*, 57: 244, 1944.
[5] M. A. Soltys, *Nature*, 154: 550, 1944.
[6] I. N. Asheshov and F. Strelitz, SCIENCE, 101: 119, 1945.
[7] W. H. Feldman and H. C. Hinshaw, *Proc. Staff, Mayo Clinic*, 19: 593, 1944.

extract had been added. After incubation for 5 days at 37.5° C, the organisms were centrifuged, washed with saline and transplanted to a solid medium. Whereas the controls grew out rapidly the organisms exposed to the extract failed to show any growth.

Thirty series of experiments were performed, using the material concentrated from as many separate harvests of mold substrate, representing a total of about 500 liters of original media.

The extract showed little deterioration when incubated for 2 weeks at 37.5° C or when autoclaved at 15 pounds pressure for 15 minutes. A slight lowering of antibiotic activity was noted when incubated with normal human serum or Sorensen phosphate buffer, pH 7.2 to 7.6. No effect on the extract was noted when treated with a Paulitsch borate buffer, pH 7.2 to 7.6.

Penicillin, which has already been shown to have no effect on the tubercle bacillus,[8] was tested against the strain used in our experiments. A concentration of 1,500 units per cc of Dorset's liquid medium failed to inhibit the growth of the standard inoculum used in these studies.

A strain of the human tubercle bacillus, isolated from the sputum of a patient with advanced pulmonary tuberculosis and shown to be highly pathogenic for guinea pigs, was inhibited *in vitro* by the mold extract in preliminary tests. Further experiments now in progress include isolation and purification of the active principle and the determination of the growth conditions necessary for optimum yield of the mold product.

ISADORE E. GERBER
MILTON GROSS
HUDSON COUNTY TUBERCULOSIS HOSPITAL,
JERSEY CITY, N. J.

SULFONAMIDES AND EGG-SHELL FORMATION IN THE DOMESTIC FOWL

THE action of sulfa drugs on egg-shell formation in birds has been reported in papers which appeared in the last two years. Hinshaw and McNeil[1] first noted the laying of soft-shelled eggs by turkeys and White Leghorn hens following feeding of sulfanilamide. Scott *et al.*[2] published a more comprehensive study of the effect of feeding sulfanilamide to the laying fowl. These workers concluded that sulfanilamide appears to exert a specific inhibition on the secretory ability of the shell glands.

About the same time, Benesch *et al.*,[3] feeding sulfanilamide and sulfapyridine to laying hens, reported that carbonic anhydrase appeared essential for shell formation. Their working hypothesis was based on the following: (a) the suggestion of Meldrum and Roughton[4] that carbonic anhydrase might play a rôle in egg-shell formation; (b) the finding by Common[5] that the carbonic anhydrase activity of the uterine epithelium is higher than that of the remaining oviducal tissues, (c) the demonstration by Keilin and Mann[6] that sulfonilamides of the $R\text{-}SO_2NH_2$ type specifically inhibit carbonic anhydrase. This property, however, is absent in all compounds in which the sulfonamide group is substituted, as it is, for example, in sulfapyridine and sulfathiazole. Benesch *et al.*[3] fed single doses varying from 0.1 gm/kg to 0.2 gm/kg of sulfanilamide to laying hens and observed very thinned and pitted shells. The same birds were afterwards given a similar dose of sulfapyridine, and the shells obtained were normal throughout.

The writers undertook experiments with several sulfonamides of the unsubstituted and substituted type. The sulfonamides were fed at levels of 0.3 or 0.5 per cent. of the dry mash. The experimental period lasted one week and was preceded and followed by one-week control periods.

It was found that unsubstituted sulfonamides such as Soluseptazine and Neoprontosil caused thin rough-shelled eggs similar to those obtained upon feeding sulfanilamide. The substituted sulfonamides such as sulfathiazole, sulfaguanidine, sulfamerazine and sulfadiazine had a negligible effect on shell thickness. The shells were smooth, though they appeared slightly pitted when observed under low magnification.

These results so far confirmed the conclusions of Benesch *et al.*[3] On the other hand, repeated experiments with sulfapyridine consistently revealed a decrease in shell thickness as well as a rough surface, whether this compound was fed for several days or in a single dose. The data are presented in Table 1 and Fig. 1.

TABLE 1

EFFECT OF SULFAPYRIDINE ON SHELL THICKNESS

Per cent. sulfapyridine in dry mash	Bird number	Mean shell thickness (mm)		Per cent. decrease in shell thickness
		Control period	Experimental period	
0.3	1	0.343 ± 0.004*	0.275 ± 0.013	19.7
	2	0.354 ± 0.004	0.265 ± 0.006	25.0
	3	0.371 ± 0.004	0.283 ± 0.012	23.7
	4	0.354 ± 0.004	0.267 ± 0.016	24.4

*P. E. of the mean.

[8] E. P. Abraham, E. Chain, C. M. Fletcher A. D. Gardner, N. G. Heatley, M. A. Jennings and H. W. Florey, *The Lancet*, 241: 177, 1941.

[1] W. R. Hinshaw and E. McNeil, *Poultry Sci.*, 22: 291, 1943.

[2] H. M. Scott, E. Jungherr and L. D. Matterson, *Poultry Sci.*, 23: 446, 1944.

[3] R. Benesch, N. S. Barron and C. A. Mawson, *Nature*, 153: 138, 1944.

[4] R. U. Meldrum and F. J. W. Roughton, *Jour. Physiol.*, 80: 113, 1933.

[5] R. H. Common, *Jour. Agr. Sci.*, 31: 412, 1941.

[6] D. Keilin and T. Mann, *Nature*, 146: 164, 1940.

In four White Leghorns (Table 1), the decrease in shell thickness varied between 19 and 25 per cent. In Fig. 1, it is seen that a single dose of sulfapyridine affected the shell thickness for at least four days. The feeding of the same substance at 0.3 per cent. level in the dry mash for a period of six days gave thinner shells and upon withdrawal of the drug, the effect was observed for three to four days (Fig. 1). These findings are analogous to those of Benesch *et al.*[7] who note that sulfanilamide and sulfapyridine both inhibit to the same extent the calcification of the femurs in rat foetuses.

It is believed that this effect of sulfapyridine on shell formation, though not in agreement with the observations of Benesch *et al.*,[3] does not exclude carbonic anhydrase as a factor in shell formation. One is led to suggest, however, that certain sulfonamides such as sulfapyridine may interfere with normal shell formation by inhibiting enzymes other than carbonic anhydrase. A temporary vitamin deficiency always remains a possibility when dealing with sulfa drugs.

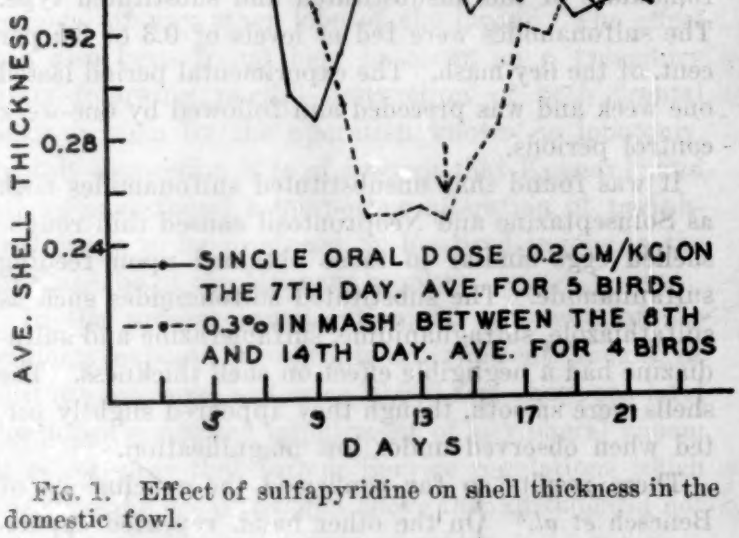


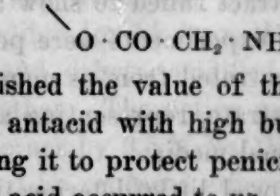
FIG. 1. Effect of sulfapyridine on shell thickness in the domestic fowl.

RICHARD BERNARD
P. GENEST

DEPARTMENT OF BIOLOGY,
LAVAL UNIVERSITY,
QUEBEC

ORAL PENICILLIN WITH BASIC ALUMINUM AMINOACETATE

RECENTLY in this laboratory[1] a new antacid, basic aluminum aminoacetate, was synthesized and studied pharmacologically and clinically. The structure proposed for the compound is



Having established the value of the compound as a rapidly active antacid with high buffer capacity, the thought of using it to protect penicillin from destruction by gastric acid occurred to us. Libby[2] has shown that effective concentrations of penicillin may be obtained in dog's serum after the oral administration of the drug suspended in oil.

Penicillin was acidified with artificial gastric juice[3] and other samples were treated with gastric juice buffered with basic aluminum aminoacetate to pH 4 to 4.5. The activity of each sample of penicillin was determined by the agar cup against staphylococcus aureus as compared with the untreated drug by the method of Abraham[4] *et al.* Gastric juice destroyed completely the activity of the drug. The penicillin treated with gastric juice buffered with the antacid was from 50 to 70 per cent. as active as the untreated penicillin.

Twelve individuals were given 100,000 units of penicillin mixed with 3 grams of basic aluminum aminoacetate, suspended in 100 to 150 cc of water. The mixture was administered in the morning on a fasting stomach. Blood samples were taken 2, 3, 5 and 7 hours after administration and in these serum levels of penicillin were determined by the method of Rake and Jones.[5]

Wide variations were found in the rates of absorption and/or excretion. Effective levels were obtained soon after ingestion and the presence of the drug in the serum, in some cases, could be detected 7 hours after ingestion. Table 1 gives average serum concentrations with respect to time in these 12 individuals.

TABLE 1

SERUM LEVELS OF PENICILLIN
Oxford units per 100 cc serum

Time after ingestion	2 hrs.	3 hrs.	5 hrs.	7 hrs.
Units	39	68	37	17

By the Abraham[4] method penicillin was shown also to be present in the urine 2 hours after ingestion.

SUMMARY

This method appears to be suitable for the oral administration of penicillin. Basic aluminum amino-

[7] R. Benesch, M. R. A. Chance and L. E. Glynn, *Nature*, 155: 204, 1945.

[1] J. C. Krantz, Jr., D. V. Kibler and F. K. Bell, *Jour. Pharmacol. and Exp. Therap.*, 82: 247, 1944.

[2] R. L. Libby, SCIENCE, 101: 178, 1945.

[3] J. C. Krantz, Jr., and A. A. Silver, *Annal. Int. Med.*, 4: 441, 1931.

[4] E. P. Abraham *et al.*, *Lancet*, 2: 177, 1941.

[5] G. Rake and H. Jones, *Proc. Soc. Exp. Biol. and Med.*, 52: 136, 1943.

acetate seems admirably suited for this purpose. It is neutral and buffers gastric acidity to pH 4 to 4.5. While this work was in progress McDermott *et al.*[6] successfully employed magnesium trisilicate in this manner.

Clinical work is now in progress using the combination in infections known to be susceptible to parenteral penicillin therapy.

JOHN C. KRANTZ, JR.
WILLIAM E. EVANS, JR.
JAMES G. MCALPINE

SCHOOL OF MEDICINE,
UNIVERSITY OF MARYLAND,
BALTIMORE, MD.

CORNEAL VASCULARIZATION IN RATS ON A TRYPTOPHANE DEFICIENT DIET[1]

IN a previous publication[2] we have reported that both weanling and adult rats developed vascularization of the cornea within two to three weeks on a tryptophane deficient diet. Inasmuch as corneal vascularization has also been repeatedly reported to be a manifestation of riboflavin deficiency in the rat and man,[3] the need for an inquiry into the apparently dual etiology of the symptom was obvious. Since the animals maintained on the tryptophane-supplemented tryptophane deficient diet grew normally and failed to show ocular lesions, it was felt that this diet contained adequate quantities of riboflavin and the possibility that the vascularization might arise from increased riboflavin requirement which was not met by the tryptophane deficient diet needed investigation.

To test this possibility, 18 normal weanling male and female rats (50–60 gm) from a hybrid albino and hooded Norwegian rat colony were divided into two groups of 9, which were fed on the tryptophane deficient diet.[4] One of these groups was given daily a freshly prepared riboflavin solution (30 γ per cc) to drink from amber-colored, glass-graduated drinking tubes, and the other group, serving as a control, received tap water instead. Despite an average daily intake of 120 γ of riboflavin, the rats of the riboflavin supplemented group developed corneal vascularization and cataracts[5] with a rapidity and incidence equal to that of the control group. Moreover, the weight losses and general poor appearance of the animals in both groups were similar to those previously reported. After 5 weeks, the riboflavin supplementation for the first group was discontinued and both groups of animals were fed the tryptophane-supplemented tryptophane deficient diet.[4] On this regimen, the animals gained weight rapidly, and complete recovery from the corneal lesions with partial disappearance of the cataracts was noted.

The results of this experiment suggest that tryptophane deficiency exerts some direct effect upon the cornea, rather than inducing a deficiency of riboflavin. The recent reports of corneal vascularization in man which failed to respond to riboflavin therapy[6, 7] suggest the possibility of an exogenous or endogenous deficiency of tryptophane and the employment of tryptophane as a therapeutic measure.

ANTHONY A. ALBANESE
DEPARTMENT OF PEDIATRICS,
THE JOHNS HOPKINS UNIVERSITY

THE SOLUTION OF SOIL MINERALS IN DILUTE ACIDS

MANY soil minerals, particularly those of the montmorillonite group, are known to dissolve or disperse readily in water solutions containing 0.01 to 0.4 per cent. acid.[1] The evaporated clear sol has approximately the composition of the residue and of the mineral from which it was derived, going from sol to gel to amorphous solid as evaporation proceeds. Solubilities as high as 60 per cent. of the clay have been found by the writer for halloysite and montmorillonite. High solubility requires sufficient acid to take the bases and sufficient water to dissolve the silica set free by removal of the bases. The solubility of an ordinary salt does not depend upon the amount of salt present, but that of a clay may vary by a factor of 4, as clay alone is varied.

The problem is to find definite relations between the amount of sol formed and the amounts of acid, clay and water present. Analyses of residues, of the dried sols and of the water-soluble portion of the latter indicate the nature of the attack and of the preferred recombination. Any exact relations found supply a foundation for theoretical generalizations.

Such an investigation of the simple mineral halloysite has been reported by the writer[1] and formed the basis of the present work on montmorillonite by the same method. Starting with a pure halloysite analyzing $Al_2O_3 \cdot 2SiO_2 \cdot 3.4\ H_2O$ under room conditions after grinding to 0.1 mm, the washed sol after drying at 160° C was found to be $2Al_2O_3 \cdot 3SiO_2 \cdot 7H_2O$

[6] W. McDermott *et al.*, SCIENCE, 101: 228, 1945.

[1] This investigation was aided by grants from the Rockefeller Foundation and Nutrition Foundation, Inc.

[2] A. A. Albanese and W. Buschke, SCIENCE, 95: 584, 1942.

[3] O. A. Bessey and S. B. Wolbach, *Jour. Exp. Med.*, 69: 1, 1939; V. P. Sydenstricker, W. H. Sebrell, H. M. Cleckley and H. D. Kruse, *Jour. Am. Med. Asn.*, 114: 2437, 1940.

[4] A. A. Albanese, L. E. Holt, C. Kajdi, J. E. Frankston, *Jour. Biol. Chem.*, 148: 299, 1943.

[5] We are indebted to Dr. Wilhelm Buschke for some of these examinations.

[6] H. Scarborough, *Brit. Med. Jour.* 11: 601, 1942.

[7] T. E. Machella and P. R. McDonald, *Am. Jour. Med. Sci.*, 205: 214, 1943.

[1] The formation of colloid from halloysite in dilute acid solutions, *Jour. Wash. Acad. Sci.*, April 15, 1944, contains references to previous work.

through a wide (16:1) range of concentrations in the 27 combinations investigated. The sol from solutions less than 0.01 per cent. acid runs higher in SiO_2, that from solutions above 0.3 per cent. acid higher in Al_2O_3. Test runs with kaolinite and muscovite instead of halloysite gave a sol of the same composition, $2Al_2O_3 \cdot 3SiO_2 \cdot 7H_2O$. These results indicate that the sol formed is not merely a peptized dispersion of the original mineral and that there is a preferred composition. That it is not merely a coprecipitation of alumina and silica is indicated both by the constancy in composition and by the low pH (1.5 to 2.5) of the solutions formed.

The quantitative relation found for halloysite between sol (S) formed and the acid (A, HCl), clay (C) and water (W) reacted was

(1) $\text{Log } S = \log A + 0.322 \log C - 0.318 \log W - 1.421$

using natural logarithms. S and C are in grams, the unit for A is 0.75 gram and for W is one liter. This may be written simply

(2) $$4.14 \frac{S}{A} = \left(\frac{C}{W}\right)^{.32}$$

or the ratio of sol to acid is proportional to about the cube root of the clay concentration in grams per liter.

The chemical processes involved appear to be very simple. After the clay mineral has adsorbed sufficient anions, it is attacked by them. Free silica liberated and chlorides formed go into solution, the chlorides are hydrolyzed, the alumina set free combining with the free silica to form hydrosol, while the acid set free by hydrolysis returns to the clay to form more chlorides. Action ceases in each run when the potential of the accumulated sol becomes equal to that of the residual mineral. The mass action "constant" varies with conditions. For C and W each = 1, S = 0.2415A. The writer has not yet been able to break down (1) into a set of general laws even with the help of the Gibbs condition that each component has the same chemical potential in all its phases. Attempts to form allophane from $AlCl_3$ and silica solution in proper proportion, with water and pH adjusted to the proper values, gave no recombination. From this it is concluded that only *nascent* ions of silica and alumina are able to recombine. While the sol formed is within the range of allophanes in composition it is slightly lower in silica than the average.

Working with montmorillonite instead of halloysite as soluble mineral, the center of interest is still sufficient acid (HCl) to dissolve the bases with sufficient water to dissolve the silica set free or one gram of acid and one liter of water to each gram of clay. One half, 1 and 2 times these amounts were run in their 27 combinations at 96–98° C for 72 hours. Of these 27 combinations, 8 are duplicates except for overall amount (such as 1:2:1 and 1/2:1:1/2), these serving to check results.

After reaching equilibrium, the final 16 hours without stirring, the clear solution was removed with a suction flask, evaporated and dried at 160° C and weighed. This residue was composed of the sol (S) and water-soluble chlorides which were separated by a ten-minute treatment in 150 cc of hot distilled water. Analysis of the chlorides, the sol and the residue of the original clay completed each run. The amount of chloride-free sol ranged from 7.4 to 63 per cent. of the clay used.

The montmorillonite used was the very pure oligocene bentonite from the Husband farm in northwestern Smith County, Miss., composed largely of shards and containing little or no alien sedimentary or redeposited material. Analyses by R. E. Stevens gave:

SiO_2	50.38	CaO	1.26
Al_2O_3	17.24	K_2O	0.51
Fe_2O_3	2.76	H_2O-	12.30
MgO	4.58	H_2O+	10.52

with traces of FeO and Na_2O. A few hours in hot 20 per cent. HCl removes the bases from this clay, leaving water-soluble pure silica. Dilute acid comes to equilibrium with it.

The sol formed showed a nearly constant composition averaging $Al_2O_3 \cdot 4.1\ SiO_2 \cdot 1.5\ H_2O$ for the 27 experiments with no systematic variation as clay, acid and water were independently varied in the range 1/2, 1 and 2 units, indicating the formation of a definite compound like an amorphous pyrophyllite. If it were an adsorption effect, its composition would have varied with the concentration of either silica or alumina (or both) remaining in solution. Only traces of either were found in the water-soluble portion separated from the sol. The molar ratios $SiO_2 : Al_2O_3$ found ranged from 3.8 to 4.5 (averaging 4.1), apparently due to accidental variations in stirring or rate of heating but not to the large variations in the clay : acid : water ratios. All Ca and Mg removed from the original clay remained as chlorides in the solution. None of either recombined with the aluminosilicate sol. The Fe behaved like the Al. The pH of the solution ranged from 2.5 to 3.5 and dropped as it evaporated until free acid was gone so that coprecipitation (of alumina with silica) seemed very unlikely.

The quantitative relation between sol (S), clay (C), acid (A) and water (W) found for montmorillonite clay may be summarized in the relation

(3) $\text{Log } S = .756 \log A + .424 \log C - .156 \log W - 1.55$

in natural logarithms; sol, acid and clay are in grams, water in liters. With C = 1 and W = 1

(4) $S = 0.212\ A^{0.756}$

These relations differ essentially from those (1) and (2) for sols from halloysite. In (1) the ratio log

S:log A averaged 1.015 (essentially unity) and the coefficients of log C and log W are very nearly the same. With montmorillonite, these conditions do not obtain, perhaps because the Cl ions are in four combinations instead of only two (Al and water). It is not that Ca and Mg take part of the acid, for all those elements in one gram of this clay would take only 0.1 gram of HCl. The effect is in the nature of a lowering of the chemical potential of the acid in a fixed ratio.

The complete replacement of shells by montmorillonite (Pontotoc, Miss.) indicates that aluminosilicate sols may be deposited under conditions that suffice to completely remove other bases present in the shells. Very slowly percolating ground waters, saturated with CO_2 (about 0.03 per cent.) from the air, could readily take up aluminosilicates and redeposit them later on contacting alkaline earth or on reaching an exposure. On the other hand, drainage waters contain chiefly soluble salts, very little alumina or aluminosilicate and SiO_2 is low except when alkalies are present.

The writer in 1932 made solutions of 22 different clay minerals in 0.2 per cent. HCl. The yield of washed residue from a liter of evaporated solution was from one to two grams in every case except for pyrophyllite, sericite and bauxite, which gave less than half a gram. In every case the recovered material closely resembled montmorillonite in composition but was low in Ca, Mg and alkalies. Even soil, glauconite and the fines associated with decomposed (D.C.) granite yield readily to dilute acid, but more slowly than the bentonites. Rain water, saturated with the CO_2 of the atmosphere, would have a concentration of about .03 per cent., well within the range investigated. Given sufficient water to dissolve the silica set free (about five liters per gram at earth temperatures), ground waters should maintain a steady supply of colloids in all ordinary soils.

SUMMARY

Montmorillonite goes readily into solution in slightly acid water. In strong acids only bases, in pure water only free silica is removed.

In the range from 0.02 to 0.5 per cent. acid, both bases and silica go into solution and recombine as an aluminosilicate sol and as highly soluble salts.

The sol recovered by evaporation, washing and drying is an amorphous colloid near pyrophyllite in composition, $Al_2O_3 \cdot mSiO_2 \cdot nH_2O$, with m averaging 4.1 (3.9 to 4.5) and n about 1.5. The slight variation in m is unrelated to either sol, acid or clay concentration.

A general characteristic relation between the amount of sol formed and the amounts of clay, acid and water used has been found for montmorillonite clays. This relation differs in two essential properties from that previously deduced for halloysite-allophane solutions. The variation with temperature of the constants of these equations remains to be investigated.

P. G. NUTTING

WASHINGTON, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLIFIED METHOD FOR THE ASSAY OF ANTIBIOTICS

AMONG the various methods used for the assay of penicillin and other antibiotics, Heatley's[1] cylinder method and its modifications is given preference by many investigators. While it has been found reliable and accurate in the hands of a team of skilled workers, the somewhat tedious and time-consuming preparatory procedure has proved a handicap for smaller laboratories who lack a sufficient number of highly trained personnel to carry out the preliminary work. The method described here has, we believe, the advantage of greater simplicity.

Principle: Soft nutrient agar (about 0.3 per cent.) is inoculated in bulk with the test organism, distributed into tubes and left to solidify in an upright position. The solution to be tested is added on top of the stab. The intensity of antibiotic activity is determined by the depth of the clear zone of growth inhibition extending downwards from the area of contact between the agar and the solution.

Details of the method: The composition of the nutrient medium is of no importance provided that it allows abundant growth of the test organism and that a standard of known activity is used with every test. In our experience the following composition proved to be satisfactory:

(a) For staphylococci:	Bacto-peptone No. 3	20	grams
	Sod. chloride	8.5	"
	Glucose	10	"
	Agar (Agar Products Co.[2])	3	"
	Dist. water	1,000	ml
(b) For *B. coli:*	Bacto-peptone No. 3	20	grams
	Sod. chloride	8.5	"
	Sod. nitrate	1.5	"
	Agar (Agar Products Co.[2])	3	"
	Dist. water	1,000	ml

The reaction of both media is adjusted to pH 6.5–6.6.

The concentration and the brand of agar influences the degree of diffusion of the active substance. In composing the medium the following rule is suggested: the optimal quantity of agar is the least amount which, during the performance of the test, allows the addition of fluid on the top of the agar without

[1] N. G. Heatley, *Biochem. Jour.*, 38: 61, 1944.

breaking its surface. We find that with the brand of agar recommended[2] a concentration of 0.3 per cent. gives satisfactory results. Another brand tried required higher concentration, resulting in diminished diffusion of the active substance. The addition of glucose for staphylococci and of sodium nitrate for *B. coli* insures good growth in the depth of the medium. The medium is sterilized in bulk at 115° C (10 lbs. pressure) for 20 minutes and cooled down to 40°–42° C. One agar slant of a 24-hours old culture of the test organism is washed with 5 ml of saline, and 0.2 ml of this emulsion is added to 1 litre of the medium, which is then distributed into tubes to a height of approximately 5 cm, the diameter of the tube being of no importance. The tubes are placed immediately in the refrigerator and are ready for use after two hours, but can be kept for at least one week.

The solutions to be tested, which need not be sterile, should not be excessively acid or alkaline. They can be diluted with water or any suitable buffer between pH 5 and 8. They must not contain ether or chloroform and not more than 10 per cent. alcohol or acetone. Approximately 0.5 ml of each solution (the exact volume does not matter) is pipetted on top of the agar stab. Standard solutions are treated in the same way. After overnight incubation, the degree of inhibition can be measured by placing a transparent millimeter scale on the wall of the tube or by the use of a pointed caliper.

The assay of penicillin is carried out in the same way as described for the cylinder method, *i.e.*, several dilutions of a standard are set up simultaneously with the unknown, and a graph is constructed by plotting the zone of inhibition in mm against the number of units per ml. Using amounts of penicillin between 0.2 and 2 units/ml a curve similar in shape to that given by Heatley is obtained.

Being based on the same principle as the cup assay, the method is subject to the same limitations, *i.e.*, the diffusibility of the inhibiting substance and a number of other factors are apt to influence the results.

During the past year the method has been successfully applied to the study of a number of other antibiotics derived from moulds and has proved particularly useful in the survey of large numbers of mould cultures and in the follow-up of the developing antibiotic activity.

IGOR N. ASHESHOV
FRIEDA STRELITZ

SCHOOL OF MEDICINE,
UNIVERSITY OF WESTERN ONTARIO

[2] Agar, powdered, natural. Agar Products Company, 616–618 North Robertson Blvd., Los Angeles 46, Calif.

SEPARATORY FUNNELS AS EXPERIMENTAL CHAMBERS IN STUDIES OF INSECT PHYSIOLOGY

IN studies of insect physiology an array of experimental chambers is frequently required within which the animals can be exposed to various gases or vapors. Preferably, such chambers should be not only durable and inexpensive, but also transparent, air-tight and capable of being easily washed out with and sealed to contain the gas mixtures.

I wish to call attention to the fact that separatory funnels fulfil these requirements in every respect, although they have apparently not been previously used for this purpose. The gas mixtures are readily introduced through the stem of the funnel, the chamber, by virtue of its smooth contours, easily washed out, and, most important, the experimental conditions then maintained by lubricated ground-glass seals at both ends. The further fact that separatory funnels in a variety of sizes and shapes are already at hand in most laboratories is not the least advantage at the present time.

In experiments in which one desires to test a large number of insects within a single chamber, it may prove convenient to enclose each animal within a gelatin capsule of suitable size. In order to insure continuous equilibration with the gas mixture in the funnel, numerous perforations should previously be made with a hot needle in both ends of each capsule. The capsules can then be numbered with ink and, if so desired, arranged in a continuous strip by placing them transversely between two longitudinal lengths of Scotch tape.

In prolonged experiments the atmosphere in the funnels can be washed out and renewed at suitable intervals. In studies not involving gas mixtures containing carbon dioxide, a loosely plugged glass vial containing soda lime should always be enclosed in the chamber.

CARROLL M. WILLIAMS

SOCIETY OF FELLOWS,
HARVARD UNIVERSITY

SCIENTIFIC BOOKS

IMMUNO-CATALYSIS

Immuno-Catalysis. By M. G. SEVAG. Pp. xv + 272. Illustrated. Springfield (Ill.) and Baltimore: Charles C Thomas. 1945. $4.50.

THE scope of this book is well stated in the preface by Dr. Stuart Mudd: "The fullness of the integration possible between the fields of enzyme chemistry, immunochemistry and the mechanisms of infectious disease, has, indeed, in the writer's belief, been indicated for the first time in this volume . . ." As stated, the

rge common denominator of enzymology and immunology has long been perceived. The basic theoetical considerations have been formulated, but hitherto they have not been extensively explored in the ght of modern developments in these fields, and with view to elucidation of concrete mechanisms.

The subject is considered in five sections: (1) "Antiens as Biocatalysts"; (2) "Antibody as a Specific nzyme Inhibitor"; (3) "Anti-Enzyme Immunity"; 4) "Immunity against Bacterial Enzymes," and (5) The Problem of Antibody Formation against Resiratory Enzymes."

The first section deals with the characteristics of talysis in general and reviews the data showing that antigen functions as a catalyst: (a) one molecule an antigen induces the formation of many moleles of antibody; (b) the antigen (catalyst) forms part of the resulting antibody (reaction product);) the reaction catalyzed is thermodynamically posble regardless of the presence of the catalyst. The ature of antibodies and current theories of the echanism of their formation are summarized. Of pecial interest is a discussion of the directive effects optically active catalysts upon certain simple chemal reactions.

In the second section, the hypothesis is advanced at since antigens are catalysts and "since practically l proteins are antigenic, the conclusion appears to be escapable that all proteins are endowed with catatic activity." (The possibility that certain non-protein substances are antigenic is considered briefly and et aside on the grounds that it is not proved that such ubstances do not combine with proteins *in vivo*, to rm the complete antigen.) This hypothesis leads to e following analogy:

Antigen + globulin factors → Antibody globulin
Enzyme + substrate → Reaction products

Hence antigen and enzyme, globulin factors and subrate, and antibodies and reaction products, respecively, are regarded as counterparts, and the "neutralzation" of an antigen by its antibody is comparable o the specific inhibition of an enzyme by the reaction roducts. It is noted that this viewpoint differs from he usual one, wherein the relationship of antibody to ntigen has been likened to that of enzyme to subrate.

The remainder of the second section, and of the ook, is largely devoted to a summation of experiental data bearing on the above analogy, principally nder the headings of the formation of specific inibitors in enzyme reactions and of antibodies against nzymes. The anomalous failure of the prosthetic roups of respiratory enzymes to function as haptens s considered. Particularly commendable is the auhor's broad conception of bacterial toxins and the recognition of bacterial enzymes as toxins, points concerning which too restricted a view has been too often taken.

In the formulation of his ideas, Dr. Sevag has consulted more than a thousand publications, of which 482 constitute the bibliography of his book. Immunologists and enzymologists will be indebted to him for the critical collation of so much literature, much of it not readily accessible previously.

The author has successfully avoided the pitfall of unnecessary duplication of basic material adequately treated elsewhere. As a consequence, this is no book for the neophyte. The reader will profit most if he has a solid foundation in immunology and enzymology. Furthermore, he who desires a didactic presentation will be disappointed, for Dr. Sevag does not pretend to provide the ultimate solution of the problems he discusses—quite the contrary, he attempts only to point the way. Each reader will find many opportunities to take issue with the author, who, one feels, was fully aware of the alternatives when he chose particular conclusions. The present reviewer surmises that the usefulness of Dr. Sevag's book will derive as much from the disagreement and consequent experimentation that it will catalyze, as from its factual content.

HENRY W. SCHERP
SCHOOL OF MEDICINE AND DENTISTRY,
UNIVERSITY OF ROCHESTER

MOSQUITOES OF NEW JERSEY

The Mosquitoes of New Jersey and Their Control. By THOMAS J. HEADLEE. 9 × 6 inches. x + 326 p. 16 pl. 87 figs. New Brunswick: Rutgers University Press. 1945. $4.00.

IN early times the travelers who wrote books frequently paid their respects in uncomplimentary terms to the mosquitoes of New Jersey and elsewhere. But in spite of the mosquito problem that persisted for years to the great annoyance of large numbers of our population, the entomologists of this country did not pay much attention to it until around 1900. According to the "Bibliography of American Economic Entomology," the 2,418 separate titles by B. D. Walsh and C. V. Riley from 1860 to 1888 include only two that deal with mosquitoes. During the same period the 3,006 titles by state and other entomologists include only 4 on mosquitoes. From 1888 to 1896, the 3,956 references include 19 on mosquitoes, 10 of which are either by L. O. Howard or by Riley and Howard. From 1896 to 1900, out of 1,882 titles, 55 are on mosquitoes. During this long period economic entomologists were concerned mainly with insects injurious to crops.

Such a condition no longer exists and we now have

an extensive literature on mosquitoes to which Dr. Headlee's book is among the latest contributions. Dr. Headlee is well qualified to write with authority on this subject because of his long association with all aspects of the mosquito problem in New Jersey, including those of leadership and initiative in organizing control work. His book is designed to furnish exactly the type of information that is needed by entomologists, mosquito control workers, sanitary engineers, public health officials and others, for a basic, intelligent understanding of mosquito problems and their solution.

There is a very short chapter on the value of mosquito control, followed by a larger one on the structure and classification of mosquitoes, including keys for the separation of adults and larvae. One set of keys involving the use of microscopic characters is designed for the laboratory, and another, involving characters that can be seen by the use of the eye and a hand lens, is intended for field use. This is a distinction that should appeal to field workers. Chapter 3 is devoted to the mosquito fauna of New Jersey and the numerical abundance of New Jersey species over a ten-year period, 1932 to 1941. Chapter 4, which occupies approximately 60 per cent. of the book, is concerned with mosquito biology. In this chapter will be found complete descriptions of the adults and larvae, together with information on the habits of the adult and early stages, life histories and distribution, including the author's numerous observations, for 37 species. The importance of this chapter is augmented by numerous illustrations including those of external anatomical details.

Chapter 5 deals with the influence of environment on mosquitoes, such as temperature, water, food supply, natural enemies, the attraction of mosquitoes to man and mosquito flight. The remaining 6 chapters describe the history of mosquito control in New Jersey; the principles and detailed methods of control for various types of breeding places; the use of larvicides and equipment, and specific directions for successful work; mosquito repellants; mosquito control laws of New Jersey; and the economic effect of mosquito reduction.

Dr. Headlee has incorporated in this book the results of his observations and research and the sound, practical facts that have been distilled and tested by him over many years. Its wealth of information on all phases of the problem should appeal greatly to all who are engaged in mosquito control work. There is only one section of the book in which, I think, the subject is slightly overemphasized. This is the last chapter of six pages on the economic effects of mosquito reduction, wherein large gains in taxable values are attributed solely to mosquito reduction. I have no doubt about mosquito control playing an impo tant part in bringing about these tax valuation i creases, especially along the Atlantic coast of Ne Jersey where the resorts are located, but I do n believe that the enormous increase in that porti of New Jersey lying within the New York metropol tan area was due entirely to mosquito reduction. think that economic conditions had a hand in th increase also. According to Monograph One of th "Plan of New York and Its Environs," there wa from 1900 to 1922 an increase of 321 per cent. i the number of light chemical industries in the Ne Jersey part of the metropolitan area and an increas of 253 per cent. in the number of heavy chemic industries. According to Monograph Two, durin the same period there were increases in the number o various types of metal industries in metropolitan Ne Jersey, ranging from 130 to 355 per cent. Thes movements to Metropolitan New Jersey took place bot before and after 1915, the date after which mosquito were scarce in that area. The reasons given for mo ing to New Jersey include more space, better rail an water transportation facilities, more and cheape labor, isolated locations for chemical industrie cheaper land, etc.

The title of Dr. Headlee's book indicates that applies mainly to New Jersey, but this is misleadin as many of the conditions under which mosquito breed in New Jersey are duplicated in various othe adjoining states. As a matter of fact, of the 37 specie of mosquitoes found in New Jersey, five occur as we in northeastern America, four are found in the south eastern states and 28 species are found all along th Atlantic Coast, some in many inland states. Fro this it is apparent that the usefulness of this boo extends far beyond the boundaries of New Jerse The impact of war has demonstrated again the nee for knowledge of the biology, taxonomy and contro of the Culicidæ as well as of other arthropods, an I am sure that Dr. Headlee's informative work wi meet with the favorable reception that it deserves.

HARRY B. WEISS

BOOKS RECEIVED

EINSTEIN, ALBERT. *The Meaning of Relativity.* Pp. 13 Second edition, revised. Princeton University Pres $2.00. 1945.

KING, RONOLD W. P. *Electromagnetic Engineering; Vo I, Fundamentals.* Illustrated. Pp. xiv + 580. Mc Graw-Hill Book Company. $6.00. 1945.

PANTH, BHOLA D. *Consider the Calendar.* Illustrated Pp. 138. Teachers College, Columbia University. 194

TAYLOR, NORMAN. *Cinchona in Java.* Illustrated. Pp 87. Greenberg, Publisher. $2.50. 1945.

WARTENBERG, ROBERT. *The Examination of Reflexe* Illustrated. Pp. xii + 222. The Year Book Publishers Inc., Chicago. 1945.

WILLIAMS, ROGER J. *What to Do About Vitamins.* Illus trated. Pp. vi + 56. University of Oklahoma Pres 1945. $1.00.